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THE CONSERVATIVE AND SURGICAL MANAGEMENT OF BENIGN STRICTURES OF THE ESOPHAGUS

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BENIGN strictures of the esophagus present a variety of problems which influence the choice of therapy. Management is dependent upon the etiology of the stenosis, the age of the patient, the severity and duration of obstruction, and the success or failure of previous therapy. Constant re-evaluation of each patient during the course of treatment must be considered and the therapeutic program made flexible enough to allow for minor or major changes, according to the response to treatment.

Benign strictures of the esophagus are common clinical entities. They may be congenital, inflammatory, chemical, traumatic, or surgical in origin. They vary in degree and extent from small, superficial webs to extensive fibrous stenosis or complete atresia; they range in duration from recent, acute obstruction to years of minimal or moderate disability, often of unknown or forgotten etiology.

An increasing interest of internists and surgeons in lesions of the esophagus focuses attention on the problems of benign strictures of the esophagus. A review of the literature demonstrates the large number of such cases that were treated in the past by otolaryngologists and some gastroenterologists by peroral-endoscopic or retrograde techniques. They were primarily concerned with the caustic strictures, congenital stenoses, strictures due to advanced cardiospasm, peptic ulcers of the esophagus often associated with congenitally short esophagus, or hiatus hernia.

In recent years the additional problem of stenoses following repair of esophageal atresia, resection of benign esophageal strictures, and stenosis following resection of gastric or esophageal carcinoma have created a new group of cases. These now require an evaluation not only of therapy per se,

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but also an analysis to indicate the rapidity with which this problem is increasing in order to emphasize the necessity of avoiding this serious complication, if possible, at the time of surgery.

CONGENITAL STENOSIS OF THE ESOPHAGUS

Congenital stenosis of the esophagus not associated with a congenitally short esophagus may be single or multiple webs or strictures involving segments of the esophagus varying in length from 1 to 10 cm.[1] Congenital webs are not common, and respond immediately and usually permanently to a single dilatation or a short series of dilatations. This procedure may consist of dilatation with an esophagoscope guided through the web over a string or an esophageal bougie, or with graduated mercury-filled rubber bougies that may be rapidly increased in size because of the ease with which the web responds to dilatation. Strictures of whole segments of the esophagus are more common, and from an endoscopic standpoint may be subdivided into two further groups because of their different endoscopic appearance and their variation in response to therapy. In each, the distal esophagus is most frequently involved. Esophagoscopically, the walls of one type appear extremely soft, covered with granulation tissue, and apparently devoid of mucosa. These respond rapidly to dilatation by esophagoscopy or mercury bougies. The second type of congenital segmental esophageal stenosis is a fibrosis stricture, often extremely firm (Fig. 1), and response to dilatation is slower; the stricture is more resistant to dilatation, and the lumen is not maintained for as long a postdilatation period. Many of these were discovered when a foreign body caused complete obstruction and roentgenograms of the esophagus were taken after the foreign body was removed.[2] Analysis of the history of such infants or children showed that they had been considered "feeding problems."

Twenty-three cases of congenital strictures of a segment of the esophagus have been observed in infants and children, 19 cases of congenitally short esophagus complicated by stenosis at the cardia, and one simple congenital membranous esophageal web. Of these, 38 have responded to endoscopic or retrograde dilatations. These are first performed esophagoscopically without anesthesia, or by retrograde or Plummer bougie dilatation if the strictures are particularly rigid. As soon as possible these procedures are substituted by the mercury bougie dilatation, a procedure which is less uncomfortable for the patient, but which is unsuccessful in the early, tighter stricture.

Five of this group of 43 patients with congenital stenoses have been treated surgically—2 by us and 3 elsewhere. Four of the 5 had a surgical excision of the stricture and an intrathoracic gastroesophageal anastomosis. Three, operated on elsewhere, developed a postoperative stricture at the site of anastomosis, which has required endoscopic dilatation identical to that used in the unoperated cases. One, described below, has had a similar procedure with the anastomosis above the aortic arch with no postoperative dysphagia (Fig. 1, *C* and *D*). The fifth patient had a Ramstedt or Heller type of procedure, but has required occasional endoscopic dilatation.

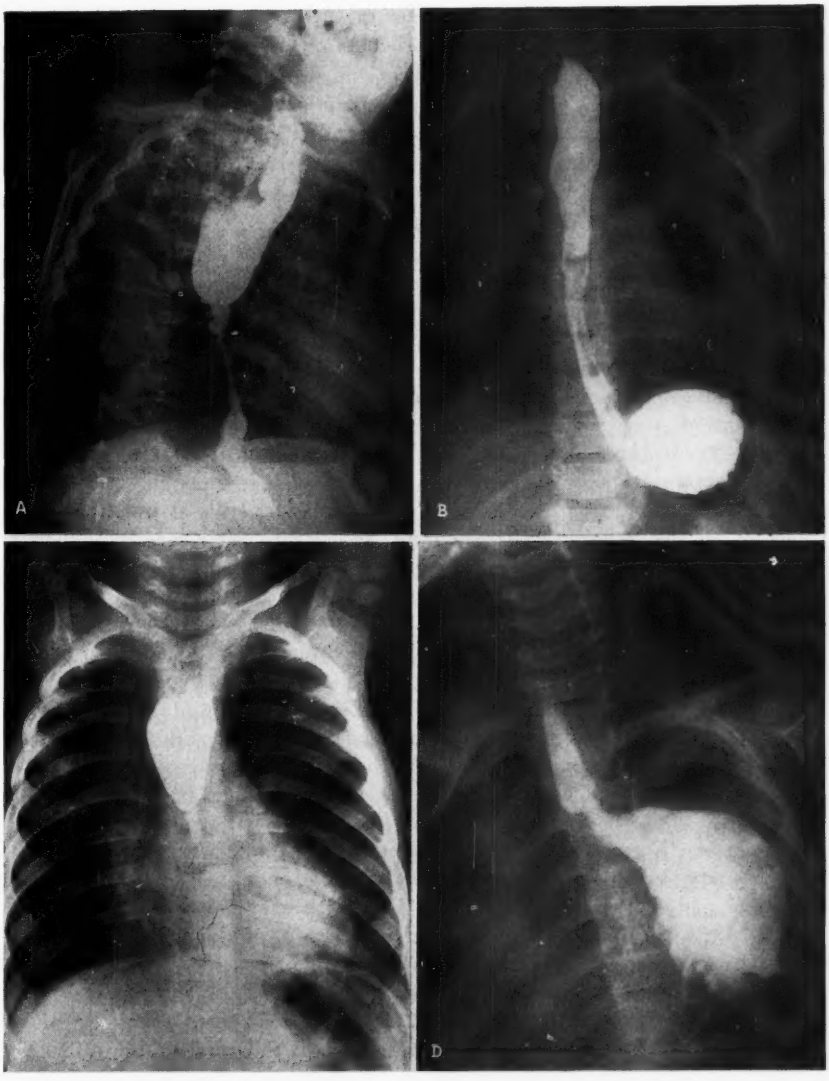

Fig. 1.—Two infants with congenital esophageal stenosis. *A*, Original roentgenogram of a stricture of the distal half of the esophagus. *B*, Same patient showing response to course of endoscopic dilatations. The caliber of this lumen has been maintained. *C*, Second infant with similar congenital fibrous stricture which did not respond satisfactorily to conservative measures. *D*, Same patient shown in *C* following resection of stricture and gastroesophageal anastomosis above the arch of the aorta.

CAUSTIC STRICTURES

We have observed 169 patients with caustic burns of the esophagus. A previous analysis of 96 consecutive cases of this group indicated that acute burns constituted one-third of the patients in this category, while the remaining two-thirds of the patients had chronic stenosis of varying degrees.[3] Twenty-seven of the 65 patients with chronic strictures had complete atresia at the time of their initial hospitalization. Dilatation from above and below and, in 5 cases, perforation of the atresic strictures with the Barretto needle under biplane fluoroscopic visualization[4, 5] resulted in recanalization of all but 2 patients who had had complete atresia. A skin tube esophagus in one of these cases was successful ten years ago. A similar procedure in the second was unsuccessful; this was followed by an anastomosis of the stomach with the cervical eophagus. Stenosis has developed at the point of anastomosis which has required repeated endoscopic dilatation. In 3 of the patients with complete atresia, all children under 3 years of age when first seen, each having had a gastrostomy of more than one year's duration, and in one adult, recanalization was successful, but because of the inability to maintain the patency of the esophagus with endoscopic dilatation, various surgical measures were ultimately employed. An esophageal-jejunal anastomosis was performed in two cases as described. The strictured distal esophagus was resected in the other two cases, and an intrathoracic gastroesophageal anastomosis was performed. Return of dysphagia necessitated resumption of endoscopic dilatations in the latter two patients to maintain the patency of the site of anastomosis. There has been one death elsewhere following esophageal resection of the caustic stricture in one patient in this series.

Retrograde, prograde, and endoscopic dilatations have been successful in opening and maintaining the esophageal lumen in the remaining patients with chronic strictures resulting from caustics. The most rapid and successful technique for this group, particularly in the presence of a gastrostomy, is the dilatation with a Plummer bougie over a string held taut in the gastrostomy opening.

In cases of acute, early, caustic burns, active dilatation is begun twenty-four to forty-eight hours after ingestion of the caustic, using the soft-rubber, smooth-tipped, catheter-like bougies filled with mercury. Graduated sizes from 16 Fr. to 30 Fr. for children or up to 48 Fr. for adults are well lubricated before being inserted in the mouth. They advance to the stomach by their own weight.[6] Two or three bougies are used daily, gradually increasing the size during the first two weeks. Dilatations are then spaced twice a week for a month, then once a week for another month. Subsequent dilatations are continued at monthly intervals for a year, and then the period between dilatations is increased. It is of utmost importance that the patient continue with this regime. The tragedy in most cases of esophageal strictures is that the family, and often the physician, are not aware that the return of normal or almost normal swallowing occurs after the acute edema associated with the original burn subsides. Treatment must be continued during this period of

relative lack of symptoms if stricture formation is to be avoided. In acute cases there has been no stricture formation in those patients seen who have maintained this course of therapy. Strictures have formed when treatment has been discontinued for one reason or another by the patient or the family, or when treatment has been delayed and the patient is seen late.

There have been seven deaths in this group of caustic strictures; one, an infant who had been given lactic acid by accident was first seen approximately six weeks after the ingestion of the acid, and the esophagus was almost completely closed. This infant died after perforation of the esophagus which occurred during dilatation, before the present chemotherapy and antibiotics were available. The second death occurred in an 8-year-old girl and was due to aspiration pneumonia, which was the result of a chronic tracheoesophageal fistula. The third fatality was a man who had swallowed a large quantity of "boiler fluid," a combination of sulfuric acid and hydrochloric acid. He had multiple esophageal strictures, marked destruction and extensive scarring of the stomach and duodenum, and eventually required a jejunostomy for feeding purposes after a gastroenterostomy proved to be unsuccessful. Death was due to gradual inanition, and had no relation to esophageal instrumentation. The fourth patient died during the acute stage of an acid burn thirteen days after ingestion of nitric acid, four days after having coughed up a cast of the entire esophagus.[7] The fifth death followed esophageal resection of the stricture. The sixth death was due to an extensive malignancy of the upper esophagus in an adult who had a lye stricture since childhood. The seventh was that of a 2-year-old boy with an extensive burn that caused an atresia of the pharynx, larynx, and esophagus who was found dead in bed when his tracheotomy tube was apparently coughed out.

During the past five years, five perforations of the esophagus have occurred during esophagoscopic dilatation of a caustic stricture; all recovered—three with conservative management alone, one requiring mediastinotomy and the fifth a thoracotomy. No perforations have occurred during mercury bougie dilatation.

In recent years the use of cortisone and ACTH have been strongly advocated by some for the management of acute caustic burns of the esophagus. The relief of pain, the general improvement of swallowing function, and the apparent reduction in scar tissue formation have indicated that this therapy is an important adjunct to the management of these patients. Therapy suggested by Barretto,[8] Palmer,[9] Grez,[10] and others is as follows: Beginning with the first day ACTH, 5 to 7.5 mg. in children and 10 to 15 mg. in adults, is administered intravenously daily with 5 per cent glucose. Vitamins B and C, penicillin, and streptomycin are administered in adequate dosage. After the tenth to fifteenth day, cortisone, 75 to 150 mg. three times a day, is administered orally for one month. Daily mercury bouginage is begun on the fifth to tenth day. However, while the immediate effects of this early therapy are dramatic, it is becoming apparent that esophageal perforations, severe gastric hemorrhage, gastric perforation, and a rise in the incidence of gastric and particularly pyloric stenosis follow this regime.[11]

HIATAL HERNIA

The stenoses associated with hiatal hernia, peptic ulcer, feeding tube ulceration, and cardiospasm constitute a group of benign inflammatory strictures at and immediately above the cardia in adults. The association of stricture formation in hiatus hernia in our series is undoubtedly higher than in an unselected group since patients were referred because of obstructive symptoms. Medical management played a significant role in the treatment of all patients.[12] Those cases uncomplicated by stricture formation treated by surgical replacement of the supradiaphragmatic stomach and diaphragmatic repair responded satisfactorily. However, the difficult problems of management in this group are those patients in whom varying degrees of stricture formation is present at the cardia. Medical ulcer management, surgical repair of the hiatal defect and endoscopic dilatation require considerable cooperation on the part of the patient. This has been reasonably effective in most cases. In six patients, all adults, resection of the stricture and esophagogastric anastomosis has given only temporary relief at best. In each, the stenosis has re-formed in a period of from three months to two years, necessitating resumption of the endoscopic dilatations.

CARDIOSPASM

It has been demonstrated that the great majority of patients with cardiospasm respond favorably to an occasional dilatation with mercury-filled bougies, or pneumatic or hydrostatic bag dilatation. In 452 of 601 traced cases reported by Olsen,[13] 60.1 per cent responded to an initial course of hydrostatic dilatation and an estimated 75 per cent to a second course. Recurrence of symptoms varied from a few months to several years. In this series of benign strictures there were 236 cases of cardiospasm, the majority of which responded to dilatation. The procedure was first done esophagoscopically; if severe ulceration was noted, the patient was placed on ulcer management until re-examination demonstrated clearing of the ulcer. The cardia was then actively dilated with a pneumatic bag under fluoroscopic control, the passage of the bag through the cardia often facilitated by guidance over a previously swallowed thread. The fluoroscopic control of the placement of the bag is significant, as indicated by the frequency with which lack of such control fails to give adequate relief and the observation of the manner in which the bag often curls on itself as attempts are made to direct it through the cardia. In patients with extreme enlargement of the esophagus or in those whose response to dilatation is unsatisfactory, surgical consultation is recommended. The total number of patients operated on is not known. However, of nine patients who were operated on by various procedures, there were two postoperative fatalities elsewhere. Seven had a recurrence of obstructive symptoms severe enough to necessitate resumption of dilatations in much the same manner as was done prior to operation and, therefore, are discussed as postsurgical benign esophageal strictures. It is significant that the surgical procedures almost invariably give the same relief from obstructive symptoms the

patient experiences following his initial endoscopic or pneumatic bag dilatation. The response may be most gratifying to the patient for the first year or two, but, as with dilatation procedures, recurrence of symptoms gradually becomes manifest after that interval of time. Of the seven postoperative recurrences, five had gastroesophageal anastomoses with resection of the strictured segment, and two had Heller operations. Two of the seven had not been seen preoperatively; one who had a resection of the stricture and a gastroesophageal anastomosis elsewhere had been dilated unsuccessfully preoperatively. The second, who had a Heller operation, had a very minimal cardiospasm, judging by the preoperative symptoms and films, and had no preoperative esophagoscopy or dilatation of any type. The postoperative stricture undoubtedly was increased in severity by mediastinitis and empyema, the result of infection of the operative site.

This is not to be misconstrued as a condemnation of surgery for uncontrollable cases of cardiospasm. In a discussion of benign strictures of the esophagus these postoperative strictures play an increasing role both statistically and with regard to their resistance to treatment. Analysis of these failures to both peroral dilatation and external surgery (excision or muscle splitting) suggests that strictures re-form because of peptic esophagitis caused by reflux regurgitation of gastric secretions. Surgical procedures to counteract this problem have been suggested[14] and it would appear that recurrence of stenosis in these seven cases may be due to failure to include measures which will reduce the acid secretion.

Six infants with cardiospasm have been reported previously.[1] These have responded to endoscopic dilatation, although one necessitated gastrostomy and retrograde dilatation because of the severity of the stricture.

SURGICAL TREATMENT

There is agreement between the endoscopic and surgical divisions that dilatation of esophageal strictures should be continued until it becomes apparent that a functional esophagus cannot be obtained by conservative measures. We believe that even a fairly good esophagus is generally preferable to food passages which are made by various types of surgical procedures.

During the past four years at Children's Memorial Hospital, we have performed various operations on eight patients for congenital and post-lye strictures and for congenital atresia of the esophagus not associated with tracheoesophageal fistula. The more interesting of these cases will be briefly abstracted.

CASE 1.—L. B., born Dec. 7, 1943, swallowed lye when 1 year old, had a gastrostomy elsewhere, and was admitted to the Children's Memorial Hospital Sept. 4, 1946, in very poor condition with a complete esophageal atresia. The lumen was re-established endoscopically with biplane fluoroscopic guidance. During the next four years the child had many dilations of the esophagus with the Plummer dilator and later with the retrograde bougies. It finally became apparent that although the esophagus could be opened, it would not remain open without frequent dilatations.

On Nov. 17, 1950, an esophagojejunostomy was performed according to the method described by Robertson[15] (Fig. 2). A loop of jejunum was isolated and the peritoneum carefully separated from both sides of its mesentery. After cutting three primary radicles it was apparent that the jejunum would be long enough to reach to the esophagus in the neck. The jejunum was cut about ten inches distal to the ligament of Treitz. A transverse incision was now made in the neck above the manubrium and the left clavicle where the esophagus was dissected from its bed with considerable difficulty because of dense fibrous adhesions. By means of blunt dissection behind the manubrium above and behind the sternum below, mostly by finger, the retrosternal space was opened. The

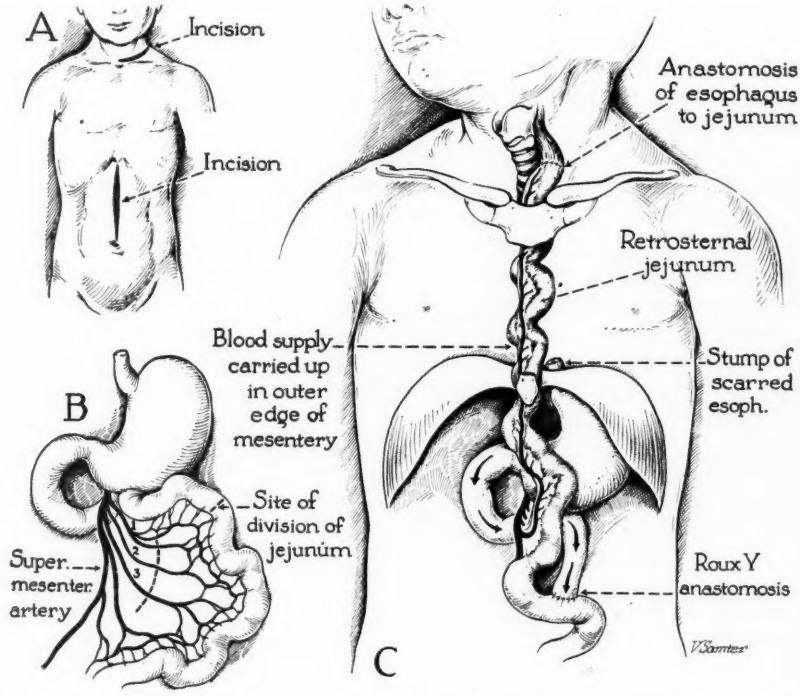

Fig. 2.—Esophagojejunostomy and Roux-Y anastomosis performed for intractable lye stricture.

proximal end of the jejunum was drawn through this tunnel behind the sternum and brought a few centimeters above the clavicle where it was anastomosed to the upper end of the esophagus by two layers of fine interrupted silk sutures. Even at this high point in the neck, the lumen of the esophagus was so narrow that a longitudinal split in its lower end was necessary to allow an adequate anastomotic channel. The distal end of the esophagus left in the chest was closed with a few silk sutures. The cut end of the jejunum in the abdomen was anastomosed to the side of the jejunum in a Roux-Y type of anastomosis. The abdomen was closed without drainage, a small Penrose drain was placed in the outer angle of the skin wound in the neck, and a temporary tracheotomy was performed. The postoperative course was uneventful except for slight infection of the neck wound, which did not delay recovery. Two weeks after surgery, fluoroscopic examination and roentgenograms (Fig. 3) showed the retrosternal jejunal esophagus functioning satisfactorily. It has continued to function satisfactorily.

CASE 2.—M. H., born Nov. 13, 1945, swallowed lye at the age of 2½ years and was admitted to Children's Memorial Hospital, April 9, 1949. He had had a gastrostomy elsewhere. Dilatations of the esophagus, constricted from the mid-cervical region to the cardia, were continued persistently until 1952. While the esophagus could be opened, often it closed down within a week to permit only the swallowing of liquids. At operation, April 25, 1952, when the child was 6½ years old, exactly the same operation was performed as in Case 1. The patient had no trouble swallowing, ate everything with the speed of the average hungry boy and had no distress. Although his gastrostomy closed spontaneously a couple of months after esophagojejunostomy, it broke open one year later and allowed study of the by-passed stomach. Analysis of the acid content of the stomach every two hours for eighteen hours showed free and combined acidity each about 10 degrees higher than normal. Gastroscopic and fluoroscopic examination of the stomach showed no variation from normal in the gastric mucosa and no filling defect.

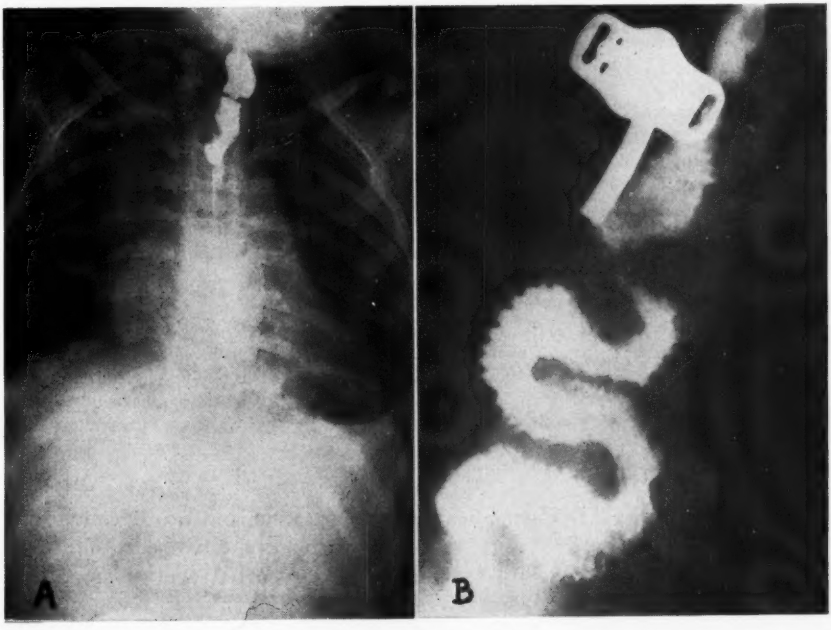

Fig. 3.—Pre- and postoperative esophagrams of lye strictures (Case 1), operated according to the procedure illustrated in Fig. 2. *A*, Preoperative film showing fibrous stricture of distal one-third of esophagus and high, firm, fibrous web. *B*, Esophagojejunostomy above the clavicle. The tracheotomy was temporary.

CASE 3.—K. K., born Aug. 26, 1951, was admitted to the hospital on August 30, with congenital atresia of the esophagus without tracheoesophageal fistula. A gastrostomy was promptly done. A small catheter passed through the gastrostomy tube was directed into the lower end of the esophagus which was demonstrated to be about a centimeter long. Lipiodol studies of the upper end of the esophagus showed that it ended at the level of the second thoracic vertebra. Since it obviously was impossible—at least had been so for us in previous similar cases—to bring the ends of such widely separated segments of the esophagus together, the upper end of the esophagus was exteriorized above the left clavicle.

When the patient was three months old an esophagojejunostomy was performed according to the technique described under Case 1. Adequate length for the jejunum to reach to the cervical esophagus was obtainable by section of only two primary arcade vessels. The jejunum placed behind the sternum was easily brought to the cervical esophagus, but even though only two arterial radicles had been cut, the jejunum was a bit dusky after anastomosis when the upper end of the esophagus had been completed. Following operation much swelling and considerable infection occurred about the neck wound; some sloughed tissue was extruded. Saliva appeared in considerable quantities and a swallow of Lipiodol showed nothing going through the jejunum.

On Jan. 4, 1952, the neck was explored and the distal end of the jejunum could not be found above the manubrium. We assumed that the end had sloughed away. The upper end of the esophagus was exteriorized and the patient sent home. About eleven months later the child returned to the hospital and on Nov. 13, 1952, the upper abdomen was opened and the proximal part of the limb of the jejunum previously placed behind the sternum was identified. Into it 10 c.c. of Lipiodol was injected; roentgenograms showed that the jejunum was still intact to approximately the upper edge of the manubrium. The sternum was then split longitudinally and the jejunal limb freed from surrounding tissues. Only at the upper end were the adhesions dense. Fortunately, after freeing the jejunum without impairing its blood supply, its upper end could be placed near the previously exteriorized esophagus. Because healing had been by primary union, it seemed safe, on Nov. 23, 1953, to explore the neck and complete the anastomosis between jejunum and esophagus. Although there was no tension on the suture line, the anastomosis broke down and saliva was discharged from the neck wound. However, a swallow of Lipiodol showed tiny quantities of the contrast medium going through the jejunum.

The child was sent home again for six months. During all of this time the gastrostomy tube was, of course, in place for feeding. On return to the hospital, unsuccessful attempts were made to get a string through the anastomosis as a guide to dilatation. The child could swallow liquids which ballooned out the esophagus and slowly went through the stricture. Attempts to dilate with an esophagoscope also met with failure. On April 12, 1954, the neck was again explored; after separating many adhesions the intact, but markedly constricted anastomosis, was exposed. The stricture was cut longitudinally and sewed transversely over a No. 20 Fr. catheter. Postoperative healing has been by primary union, but the child cannot swallow fluids without difficulty. Roentgenogram studies show considerable stricture.

We have performed esophagojejunostomies as described on three patients; two had no postoperative complications of any kind and no digestive difficulties or complaints for four and two years, respectively. Failure of anastomosis in the third child has necessitated repeated operations, but an eventually satisfactory result seems assured.

Our experience is too limited to know whether an intrathoracic gastroesophagostomy is a better operation. Thus far, by-passing the stomach in two patients, each about 7 years of age, had led to no trouble. Perhaps it would be wise to attach the jejunum to the stomach now. This procedure would not be difficult since the retrosternal limb of the jejunum crosses the anterior surface of the stomach.

For a fourth patient with congenital atresia of the esophagus without tracheoesophageal fistula, previously reported,[16] the stomach was transplanted beneath the skin, but in front of the sternum. It was very unsightly in this position and eventually was successfully moved into the chest through an incision which involved cutting all the ribs and the clavicle on the left side.

Transplantation of even the jejunum beneath the skin of the anterior chest wall for an esophagojejunostomy at the neck seems less desirable to us for cosmetic reasons than retrosternal placement.

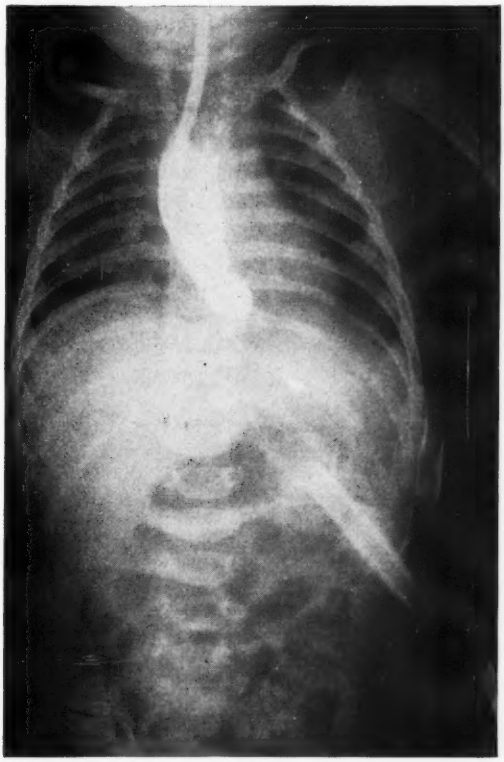

Fig. 4.—Case 4. Congenital fibrous stricture of distal esophagus necessitating gastrostomy because of rigidity of the stenosis.

CASE 4.—J. R., born March 24, 1947, was admitted to Children's Memorial Hospital, June 16, 1947, with a history of vomiting uncurdled milk in increasing quantities for nine weeks. Roentgenographic studies showed a stricture of the esophagus just above the cardiac orifice (Fig. 4). It was impossible upon repeated attempts with an esophagoscope to find an opening through the constricted esophagus. A gastrostomy was done and the child brought to normal food intake. Later, under biplane fluoroscopic observation, it was impossible to find an opening through the stricture with simultaneous approach with one esophagoscope introduced through the esophagus from above and another from below through the gastrostomy.

At operation on Sept. 12, 1947, the lower end of the esophagus was exposed through a left posterolateral chest wall incision. Except for some palpable thickening the esophagus showed no abnormality. A catheter was introduced from above to outline the beginning of the constriction. Not recognizing the pathology as anything previously seen or read about, it seemed appropriate to cut into the stricture. A longitudinal incision

through the rather firm mass revealed dense fibrous tissue which resembled in appearance, feel, and size the tumor of congenital pyloric stenosis (Fig. 5). The mucosa was then cut longitudinally, and immediately after it had been done it was regretted. The entire mass so much resembled pyloric stenosis that it might well have been treated as such, that is, by cutting the constricting tumor and leaving the mucosa intact. The catheter previously placed in the esophagus was directed into the stomach. Since the mucosa had been split, it was freed somewhat from the dense fibrous tissue on each side and closed transversely over the No. 16 catheter. The rather tough fibrous tissue with the loose adventitia lying above it could be closed transversely, after a fashion, over the sutured mucosal layer. The catheter was removed from the esophagus and the chest was drained with a

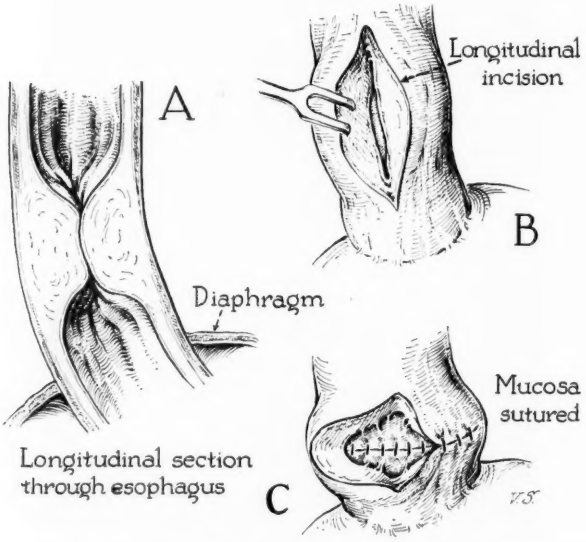

Fig. 5.—Case 4. Diagram of longitudinal incision and transverse closure of congenital fibrous stricture of distal esophagus of 3-month-old infant.

stiff tube, the open end of which was sewed in place near, but not touching, the repaired site. Discharge from the drainage tube of regurgitated stomach contents and saliva began a couple of days after surgery but ceased spontaneously; when the child was discharged from the hospital one month after operation he was able to swallow liquids and semisolid foods. The gastrostomy was allowed to close spontaneously. Occasional endoscopic dilations of the esophagus have been necessary; the patient returns occasionally for these examinations to be sure the stricture is not recurring.

This unusual case of congenital stricture was entirely new to us. A similar case has not been seen reported, but undoubtedly has occurred. We believe that another such case might be treated surgically as congenital pyloric stenosis, i.e., cutting the fibrous constriction and leaving the mucous membrane intact.

The two other patients with strictures which involved only the intrathoracic portion of the esophagus were treated surgically by gastroesophagostomy. One anastomosis for a lye stricture was performed below the arch of

the aorta; the other for a congenital stricture had to be done above the arch (Fig. 1). Although both anastomoses were done exactly the same way, the one performed below the arch has been followed by stricture which has required many postoperative dilations, the other has remained open without any difficulties or narrowing.

POSTSURGICAL STRICTURES

An aspect of benign strictures of the esophagus which is becoming of increasing concern is the postsurgical stricture. It has been mentioned under the various categories discussed above, and is now summarized as a separate entity not only because of its actual frequency, but because of the rapidity with which this group has increased. Cases may be divided into four groups: (1) stenosis following the repair of congenital esophageal atresia, with or without tracheoesophageal fistula; (2) stenosis at the point of anastomosis following the resection of a benign stenosis (congenital stenosis, lye stricture, chronic inflammatory stenosis associated with peptic ulcer of the esophagus, cardiospasm, etc.); (3) stenosis following surgery of the esophagus for nonstenosing lesions (diverticulum, thyroidectomy, etc.); and (4) stenosis following resection for carcinoma.

Stenosis Following Repair of Congenital Esophageal Atresia.—Postsurgical strictures commonly develop following repair of congenital esophageal atresia with tracheoesophageal fistula. The configuration of the proximal portion of the distal segment and the inability to bring the ends of the segments together with sufficient tissue for adequate repair are but two of the reasons that these strictures may follow anastomosis. From the standpoint of the esophagoscopist who must be responsible for maintaining the patency of the lumen at a later date, therapy should begin at the time of anastomosis if there is any question of a potential narrowing in this area. A thread passed through the stricture is of inestimable value and maintains the patency of the lumen. Without it, subsequent dilatation is hazardous and often impossible. Therefore, at the earliest indication of dysphagia the infant should be given a fine thread to swallow, this followed by a No. 14 or No. 12 woven silk thread. By passing a small catheter through the nose the thread can be tied to it, returned through the nostril, and anchored in a more satisfactory manner. If a gastrostomy is necessary for feeding purposes, the thread can be recovered in the gastrostomy opening with an aspirator, and a continuous thread established by tying the two ends together. Subsequent dilatations over this thread are the most satisfactory form of therapy, using either retrograde or olive-tipped prograde bougies.

There are twenty-six infants and children in this group. Approximately half of these were operated on elsewhere and referred later for postoperative dilatation as obstruction progressed (Fig. 6). The remaining half represents approximately one-fourth of the total group of *living* tracheoesophageal fistula patients operated on at the Children's Memorial Hospital. The early frequent esophagoscopic, retrograde, or Plummer bougie dilatations over a string are gradually decreased in frequency, with the interval between treatments being

dependent upon the symptomatology. These dilatation techniques are dispensed with as soon as possible and the easier mercury bougie dilatations can be substituted.

Fig. 6.—Stricture at site of anastomosis of the two esophageal segments of a congenital esophageal atresia and tracheoesophageal fistula.

It is of interest to note that two of the infants with these postsurgical strictures and two additional tracheoesophageal fistula infants who have not developed esophageal stenosis have serious tracheal stenoses at the site from which the lower esophageal segment was removed from the trachea and the lehiscence closed.

Recurrent Stenosis Following Resection of a Benign Stricture.—In this group may be listed three cases of recurrent stenosis following resection of lye strictures, five cases of recurrence of stenosis following resection of congenital strictures, eight cases of recurrence following resection of stenosis associated with hiatal hernia and peptic ulcer of the esophagus, and seven cases of recurrence following various surgical procedures for cardiospasm.

Stenosis Following Surgery for Nonstenosing Lesions of the Esophagus.—In addition to the surgical stenoses occurring for the most part in the distal esophagus are a group of severe benign stenoses of the cervical esophagus that have followed operative procedures for benign lesions in the neck. Two of these have followed thyroidectomy; one was severe enough to necessitate a gastrostomy before the lumen could be adequately dilated to permit a satisfactory intake. Seven have followed the removal of a pulsion (Zenker's) diverticulum of the hypopharynx. These are apparently the result of too zealous an effort at adequate, water-tight closure of the esophagus after the sac is removed, or the attempt to avoid recurrence of the diverticulum by increasing the support along the suture line with additional suture layers. When several layers of closure are made with full-thickness layers, the lumen must obviously be reduced. In one patient who had a pulsion diverticulectomy a complete atresia was present, the patient being unable to swallow his saliva. This stricture was eventually opened by retrograde dilatation through a gastrostomy. The remainder have been dilated esophagoscopically or with mercury bougies to restore normal swallowing function.

Stenosis Following Resection of Carcinoma of the Esophagus.—Repair of the esophagus following resection of a carcinoma presents surgical problems which are the result of many variable factors. Should a stricture follow such a repair, it is of minor importance in relation to the original carcinoma which has been removed. From an endoscopic standpoint, the tortuous, dense, fibrous postoperative scar is nevertheless, difficult and dangerous to dilate because of its rigidity and tortuous course, and because one must always bear in mind the possibility that the return of dysphagia may be evidence of a return of carcinoma (Fig. 7). Twenty-eight patients with resections of the lower or mid-thoracic esophagus have required repeated dilatations of the anastomosis during the past three years. Since the majority showed recurrence of the carcinoma at the anastomosis site, re-resection or the insertion of polythene tubes endoscopically has been done in addition to the repeated dilatations.

As in the postsurgical strictures following resection of benign lesions, a separate group is made up of those strictures that followed resection of malignant lesions involving the cervical esophagus. Twelve of these are postlaryngectomy stenoses in which the pharyngeal closure has been followed by stenosis because of partial pharyngeal resection. Much more complicated are those that follow the increasingly radical pharyngeal and laryngeal resections that are performed for more extensive malignant lesions of these areas. Stenoses frequently occur at both the upper and the lower sites of anastomosis of skin tubes used in these patients. Often no type of dilatation is possible because of the tortuous, subcutaneous path which has been constructed and because of the fibrous rigidity of the stricture itself. Occasionally, if the patient can swallow a thread, dilatation of the tortuous path can be accomplished to improve swallowing function. The relief such patients experience in being able to swallow their saliva, even though nutrition

has been maintained by gastrostomy feeding, is sufficient to justify hours of effort. However, this problem is so materially decreased in severity if a string is inserted at the time of surgery that it would seem justified to consider this as a routine part of these operations.

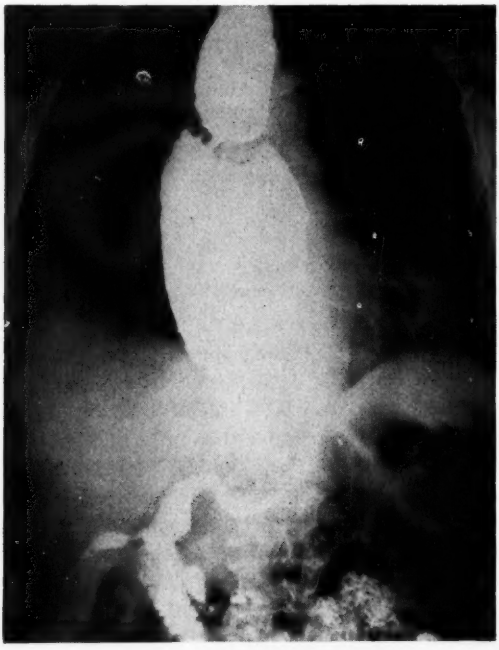

Fig. 7.—Postsurgical stricture at site of a gastroesophageal anastomosis following resection of a carcinoma of the distal esophagus.

SUMMARY AND CONCLUSIONS

The management of benign strictures of the esophagus varies according to the etiology, degree, and duration of the stricture, the age of the patient, and the success or failure of previous therapy. There is agreement between the endoscopic and surgical divisions at the Children's Memorial Hospital that dilatation of esophageal strictures should be continued until it becomes apparent that a functional esophagus cannot be obtained by conservative measures.

Dilatations of benign strictures of the esophagus are performed in several ways, depending on the location, size, and rigidity of the stricture. They may be done by esophagoscopy, either using bougies through the scope or by the scope itself; by Plummer bougies passed over a previously swallowed thread; by retrograde Tucker bougies in some gastrostomized patients; by graduated mercury-filled bougies; or by pneumatic bougies correctly placed

under fluoroscopic guidance. No anesthesia is used in infants or children, local anesthesia in adults. In our experience, the most rapid and the safest method of dilating tight, fibrous strictures has been a gastrostomy and peroral Plummer bouginage over a string held taut at the gastrostomy opening. The most satisfactory method of dilating an early, less fibrous stricture has been by graduated, mercury-filled rubber bougies.

In a review of our series of benign strictures of the esophagus there are 43 cases of congenital strictures: 1 simple web, 23 strictures of segments of the esophagus, and 19 cases of congenitally short esophagus with a stricture at the cardia. Thirty-eight responded to dilatation, 4 were operated on by excision of the stenosis and intrathoracic gastroesophageal anastomosis, and 1 was operated on by a musclesplitting procedure. Postoperatively 3 of the 4, having had a gastroesophageal anastomosis elsewhere, required resumption of endoscopic dilatations identical to those preceding operation.

There are 169 patients with caustic burns and strictures of the esophagus. Approximately one-half were chronic strictures, of which 27 had complete atresia that necessitated biplane fluoroscopic guidance to recannulate the lumen. Of those who did not respond to dilatation, skin tubes were constructed (more than ten years ago) in 2 patients; 1 was successful, 1 was not. In 2, retrosternal esophagojejunal anastomoses were performed with complete relief of dysphagia; in 3, intrathoracic gastroesophageal anastomoses were performed. Endoscopic dilatation has been necessary in these 3 because of severe strictures at the site of anastomosis. In the management of acute burns, the use of antibiotics and early bouginage by mercury-filled bougies is stressed. ACTH and cortisone produce a dramatic early relief of pain and dysphagia, but reports of severe gastric and esophageal hemorrhage, perforations and late gastric and pyloric strictures are appearing in the literature to place a note of caution on this regime.

In all of 6 adults operated on for strictures of the gastroesophageal junction associated with hiatal hernia, recurrence of the stricture at the point of the anastomosis has necessitated resumption of the peroral dilatations. In 236 cases of cardiospasm, 75 per cent have responded to an occasional pneumatic bag or mercury bougie dilatation. Of 7 patients operated upon in whom resumption of dilatation was required after surgery, 5 had had resection of the cardia and gastroesophageal anastomosis and 2 had had Heller operations; none had additional procedures designed to reduce the acid secretion of the stomach.

There were 96 patients who had benign, postsurgical strictures of the esophagus. Twenty-six were infants or children who had stenoses following repair of congenital esophageal atresia and tracheoesophageal fistula. Eighteen were patients who had developed stenoses at the site of anastomosis following resection of a benign stricture: 3 following resection of a lye stricture, 2 following resection of a peptic ulcer with stenosis, 6 following resection of a stricture associated with hiatal hernia, and 7 following surgery for cardiospasm. Nine patients had had esophageal stenosis following surgery for *non-*

stenosing esophageal lesions, 2 following thyroidectomy, and 7 following resection of a pulsion (Zenker's) diverticulum. In one of each of the latter two categories complete atresia necessitated gastrostomy and retrograde recannalization. In 28 patients seen in the last three years, benign stenosis has developed in the anastomosis following resection of carcinoma of the esophagus or stomach. In 15, stenosis of the cervical esophagus has necessitated dilatation following laryngectomy and partial pharyngectomy, or following the skin tube procedures designed to replace the esophagus in resection of carcinoma of the cervical esophagus.

Seven patients operated on for benign strictures of the esophagus at the Children's Memorial Hospital are presented. In two patients gastroesophageal anastomoses were performed: one above the arch of the aorta for a congenital stricture, who now has normal swallowing function, and one below the arch for a lye stricture with a recurrence of stenosis. One infant with a congenital fibrous stenosis immediately above the cardia had almost completely normal swallowing function following longitudinal incision and transverse suturing of the fibrous segment. Three children have had cervical gastrojejunal anastomoses, two for intractable, extensive lye strictures with complete restoration of normal swallowing function, and one infant for congenital esophageal atresia. Infection at the anastomosis site has resulted in stenosis in this region which will require further dilatation procedures or surgery. The seventh patient, reported previously, has normal swallowing function following cervical gastroesophageal anastomosis for congenital esophageal atresia.

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DISCUSSION

DR. H. BRODIE STEPHENS, San Francisco, Calif.—We have found that the simple measure of raising the head of the crib or bed two feet has been an extremely effective treatment in congenitally short esophagus. In the case of the young infant, we have the parents make a harness for the child in order to keep him properly arranged in the crib during the sleeping and resting hours. In the case of the adult, he or she is instructed to purchase a hospital bed so that the head of the bed is always elevated. This simple expedient of raising the esophagus above the level of the stomach has been an extremely effective method of keeping the stomach contents out of the esophagus. When the cardioesophageal junction is too high above the diaphragm by operation, then constantly maintaining the esophagus above the stomach by positioning will often result in the disappearance of the esophagitis that is so commonly present. In a few instances of rather severe bleeding in infants due to the lesion, we have been able to eradicate symptoms by the procedure described. In addition, we believe that we have prevented the development of stricture by insisting that the patient be always in the upright position during the resting hours.

DR. L. D. MACLEAN, Minneapolis, Minn.—We have been impressed with the extreme sensitivity of the esophageal mucosa to both acid and alkaline secretions, and particularly the therapy of at least one sequela—stricture—by means of subtotal gastric resection. While it has been impossible for us to produce this in the experimental animal to date, we thought our experience with a small group of cases might be of interest at this time.

A total of 12 cases with associated gastric, duodenal, or jejunal ulcers, and at times also paraesophageal hiatus hernia, have undergone subtotal gastric resections. They have been followed for periods of six months to fifteen years.

The difficulty of the first patient operated upon was preceded by an obstructive duodenal ulcer, as was indicated by the gastrointestinal series. Dilatations were carried out over a four-year period following development of dysphagia. He did not respond to this therapy and was operated on in September, 1939, by Dr. Wangensteen. It was not anticipated that this operation would in any way relieve the dysphagia, but it did. Dilatation had been performed approximately 100 times prior to surgery; this was required only twice in the immediate convalescent period. The patient has not suffered with dysphagia, and is working at the present time.

The difficulty of the sixth patient of this series of 12 was also preceded by duodenal ulcer, and his dysphagia became markedly worse following perforation of the ulcer. Over a period of two months it became impossible for him even to swallow his saliva, and a gastrostomy was done elsewhere. Dilatations were begun, using first a No. 5 Fr. ureteral catheter and working up to a No. 27 Fr., at which time an esophagram was taken. He underwent a subtotal gastric resection six years ago.

Of the 12 patients, all have had symptomatic improvement. Eleven of the 12 have evidence anatomically, as demonstrated by the esophagram and the ease of passing dilators, of enlargement of the esophageal lumen.

DR. E. B. BENEDICT, Boston, Mass.—Dr. Gillespie and I* have recently reported 100 cases of peptic esophagitis with stenosis of the esophagus. We believe that by having

*Benedict, E. B., and Gillespie, J. E. O'N: Peptic Stenosis of the Esophagus, Surg., Gynec. & Obst. **98:** 494-502, 1954.

the patient swallow a thread as a guide, and using that for bouginage, we can usually avoid gastrostomy, and most patients do not like a gastrostomy. About 80 per cent of our cases had a hiatus hernia and 40 per cent had an esophageal ulcer or a duodenal ulcer, or both. In the few cases that require resection, we feel that if the resection is done well above the area of esophagitis the patient will not develop postoperative stenosis. In the few cases that did have postoperative stenosis, dilatation, using the thread as a guide was satisfactory, and gastrostomy was not necessary.

DR. WILLIAM F. RIENHOFF, Jr., Baltimore, Md.—I should like to call to the attention of the American Association of Thoracic Surgery a patient upon whom I operated in 1943.* I believe the jejunum was placed retrosternally in this operation for the first time. This patient of Dr. Samuel Crowe, Professor of Otolaryngology, had a lye stricture. He had a gastrostomy for about twenty years. In order to reconstruct an esophagus, I placed his jejunum behind the sternum, but there was no connection between the stomach and the jejunum. Dr. Potts raised the question of what would happen eventually when the stomach received no food. For the last eight years this patient has had severe hemorrhages from obvious gastric or duodenal ulcers. Because he is not very cooperative, he will not come in for an operation to join the jejunum to the stomach. I want to point out, therefore, that if you do an esophagojejunostomy and leave the stomach as an empty sac exposed to its own digestive juices without any food or water or anything going through it, you are likely to have peptic ulceration.

DR. MARK M. RAVITCH, New York, N. Y.—In regard to Dr. Pott's question, I want to point out that in by-passing the stomach we may bring on subsequent diarrhea and malnutrition. That has happened to us, and we have had to reinsert the lower end of the anterior esophagoplastic jejunum into the stomach. On the other hand, there are very large series of cases in which this has not been necessary, in which growth and nutrition have been compatible with the establishment of a jejunal esophagus, extrathoracic or intrathoracic, by-passing the stomach. Yet we have had two experiences in young adults with jejunal esophagoplasties for lye strictures who developed anastomotic ulcers because the lower end of the jejunum was inserted into the stomach. Neither of those people, I believe, bled as much as Dr. Rienhoff's famous Willy Turner, whom a number of us in this room remember. They do pose problems, however, and I wonder if that type of anastomosis should not be accompanied by vagotomy and pyloroplasty.

DR. JOHN L. POOL, New York, N. Y.—I, too, should like to discuss the point raised by Dr. Potts. For replacement of the esophagus after resection of an esophageal cancer, the Ross Robertson type of procedure is available. It has the distinct advantage that the replacement procedure is a stage separate from the esophageal resection and carries a lessened mortality than the one-stage esophageal resection with immediate esophagogastrostomy. Furthermore, one can do a more complete esophagectomy. The esophagojejunostomy is in the neck and the patient is left with a good two feet of jejunum proximal to the Roux-Y anastomosis.

Although this anatomic setup is very satisfactory, there is one physiologic complication—namely, the "dump syndrome." One such patient whose stomach was still intact and who had a gastrostomy as well as the esophagojejunostomy was studied on the Metabolism Service at Memorial Hospital by Dr. Kathleen Roberts and Dr. H. T. Randall. It was found that hypotonic glucose or starch meals given by mouth produced an immediate elevation in hematocrit, diminution in plasma volume, and certain electrocardiogram changes. There was some weakness, uneasiness, and sweating. Similar type of volume of food placed through the gastrostomy produced none of these symptoms or laboratory changes. This particular patient, despite his mild disagreeable sensation, ate well and gained 20 pounds in six months although other patients with similar setups have

*Rienhoff, W. F., Jr: Intrathoracic Esophagojejunostomy for Lesions of the Upper Third of the Esophagus, South M. J. 39: 928-940, 1946.

had difficulty in regaining weight. Therefore, it may be well worth while to consider attaching the lower end of the jejunum to the stomach and attempting to keep the retrosternal segment of jejunum as short as possible.

DR. LEWIS H. BOSHER, Richmond, Va.—We have employed esophagojejunostomy or esophagocologastrostomy in the treatment of lye strictures which failed to respond to dilatation or which could not be dilated. We have used the anterior mediastinal route described by Dr. Ross Robertson. This has proved satisfactory even in small children.

If the jejunum is used for reconstruction, we believe the procedure should usually be done in two stages, elevating the jejunum through the anterior mediastinum at the first stage and performing anastomosis at the second stage. In the case of a long jejunal limb the cephalad end of the jejunum is usually quite edematous and shows some evidence of reduced blood supply. If the jejunum is elevated high into the neck, there may be enough tension on the vascular arcade to lead to thrombosis and subsequent gangrene or atrophy of the cervical portion. If the cervical portion appears dusky at the time of the first stage, it should probably be returned to the superior mediastinum, to await the second stage. The second stage is carried out seven to ten days later. The jejunum may be fished out of the superior mediastinum by the cervical approach or by separate anterior thoracotomy. At that time the distal vascular arcade is divided in one or more places which easily mobilizes 6 to 8 inches of additional jejunum. Between the first and second stages a rich intramural blood supply has developed which adequately nourishes the upper end of the jejunum.

In some patients the jejunum sloughs after the initial procedure. It is possible by doing simultaneous laparotomy, thoracotomy, and cervical incisions to remobilize the jejunum without dividing any additional mesenteric vessels, and perform a pharyngo-jejunostomy. The upper portion of 6 or 8 inches of the jejunum can be nourished by intramural blood supply.

In one child who had a complete lye stricture the jejunum was elevated and anastomosed. Between the first and second stages the jejunum was allowed to remain in the superior mediastinum, and at the second stage the vascular arcade was divided and an adequate portion easily elevated. A technique we have used to divide the vascular arcade at the second stage easily mobilizes 6 to 8 inches of jejunum.

We have also employed esophagocologastrostomy, elevating the transverse and ascending colon. The blood supply of the colon tube seems to be well-maintained, and we believe this procedure can be carried out in one stage. Barium is apparent on the colon tube which has been anastomosed to the stomach in its distal portion.

DR. F. S. GERBASI, Long Beach, Calif.—I should like to relate the experiences at the University of Michigan in congenital strictures in infants and children. There have been 14 cases of congenital stricture in the past twenty-five years, 10 in males and 4 in females. All except one had the stricture between the middle and lower third of the esophagus. Nine of the patients had symptoms before they were 15 days old. This is in contradistinction to what we read about; most of the literature says that symptoms come on when they start to eat semisolid foods. None of these infants was premature. We had 8 patients whom we were able to study early in their treatment and to show that they did not have a hiatus hernia. However, later in their treatment 3 of them did have a hiatus hernia. Of 11 cases which we were able to follow, 5 developed a hiatus hernia. All of the 11 cases had been treated with dilatations and only 4 had benefited. I agree with Dr. Holinger that these infants with congenital stenosis should be given a trial with dilatation. If they do not respond I think the stenotic area should be resected early before they acquire esophageal changes and a hiatus hernia.

DR. ROSS ROBERTSON, Vancouver, B. C.—I should like to try to answer Dr. Pott's question by describing two patients with lye strictures treated by reconstruction of the esophagus by a jejunal transplant in the anterior mediastinum. One, following a jejunal transplant, had perforation from peptic ulceration of the stomach and, in his case,

since nutrition was excellent, we did a complete gastrectomy. He has carried on since without any dumping syndrome or other difficulty and has maintained good nutrition. The other patient was a young woman who complained bitterly of dumping syndrome. In her case we did a partial gastrectomy, removing most of the acid-bearing portion of the stomach, and anastomosed the jejunum to the stomach. She has been quite well since the operation and has no discomfort after meals. In both cases we had the problem of the residual esophagus, but since the mucosa was completely destroyed we left it in; it has given no trouble.

DR. PAUL H. HOLINGER (Closing).—We appreciate the discussion on this subject. Of course we would like to believe that when a child or an adult is operated on for a benign stricture, he is cured. But when he requires dilatation after operation just as before, we wonder and he wonders why the operation was done. Most of the surgical failures we have seen, particularly those operated on elsewhere and later referred for dilatation, followed removal of the stricture and gastroesophageal anastomosis; that is the most important point we found in our survey of postsurgical strictures. Unfortunately, this simple stricture removal and anastomosis is the procedure which is most often used and which seems logical when one looks at the roentgenogram and visualizes the picture that could be obtained by cutting out the stricture. I think the discussion has been extremely helpful in pointing out that simple resection of the stricture is obsolete unless it is associated with some operation which will reduce the acid secretion of the stomach and that, while such operations are more complicated, they give results which seem much more favorable.

DR. WILLIS J. POTTS (Closing).—I must apologize for not calling attention to Dr. Rienhoff's work. Many years ago he advised intrathoracic jejunoesophagostomy for malignancies of the esophagus.

A METHOD OF PREVENTING PEPTIC ESOPHAGITIS FOLLOWING ESOPHAGOGASTROSTOMY

Experimental and Clinical Study

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TO ENSURE the aboral transit of food from the esophagus into the stomach, the junction between these two organs is augmented by a group of structures known collectively as the cardiac mechanism. This mechanism includes the valvular device at the cardiac orifice and the diaphragmatic pinchcock action of the right crus of the diaphragm at times of increased strain. The valvular mechanism of the cardiac orifice, or the "hiatal valve," consists of the synergistic action of the oblique inosculation of the esophagus into the stomach and the difference in pressure between that in the stomach and the intraluminal pressure of the esophagus.

Some regurgitation undoubtedly occurs as a physiologic process during swallowing and during, or after, the taking of food. Regurgitation is prone to occur when intraluminal esophageal pressure falls below intragastric or intra-abdominal pressure. The intra-abdominal pressure is increased by diaphragmatic and abdominal wall contraction. Contraction of the diaphragm also produces a decrease in intrathoracic pressure. Variations in intrathoracic pressure are transmitted to the esophageal lumen.[1] The intraluminal pressure of the esophagus is negative except during rises in intrathoracic pressure and following peristaltic waves. Under such circumstances the continuous reflux of stomach contents would be expected. However, the "hiatal valve" explains how food can pass from the esophagus into the stomach even if the intragastric pressure is higher. The peristaltic wave offers the increment in energy to increase the intraluminal esophageal pressure to a level above that in the stomach. The valve then opens and the bolus enters the stomach. When the increment in pressure produced by the peristaltic wave passes off, the intragastric pressure becomes higher than the intraesophageal, and the valve closes.

Donnelly[2] has shown that during inspiration the intraesophageal pressure is decreased and intragastric pressure increased. In deep inspiration also the descending diaphragm increases the angle of entry of the esophagus into the stomach. These factors would tend to decrease the competence of the valve. However, a column of barium is held up a considerable distance above

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the cardiac orifice during deep inspiration by action of the "diaphragmatic pinchcock." This pinchcock action is produced by increased tone of the right crus of the diaphragm. It comes into play with any increase of intra-abdominal pressure.

If this cardiac mechanism becomes disturbed by a pathologic development such as esophageal hiatal hernia, or by surgical means such as cardioplasty or esophagogastrostomy for obstructing lesions at the esophagogastric junction, certain undesirable secondary effects make their appearance. Surgical procedures which eliminate the cardiac mechanism are followed by repeated regurgitation of gastric juice into the esophagus. The resulting peptic esophagitis in turn may give rise to any of the generally known complications of peptic ulceration: hemorrhage, perforation, or obstruction. If the gastric juice is increased in amount or in relative acidity, the tendency to peptic ulceration is even more pronounced. It has been recently shown that normal gastric juice of normal acidity and enzyme content may produce peptic ulceration in the presence of an esophageal hiatal hernia without any primary anomaly of the secretory process itself.[3]

The appearance of peptic esophagitis following esophagogastric anastomoses has been extensively reported. In a series of 26 cases of cardiospasm treated surgically, Barrett and Franklin[4] observed the development of esophagitis with stricture formation in almost all cases. In a series of 121 gastroesophageal obstructions which were resectable, Allison and Borrie[5] found that peptic esophagitis resulted in a large number of postoperative strictures, even though the vagus nerves were completely resected. Ripley and associates,[6] in a series of 65 patients who were subjected to esophagogastrostomy or cardioplasty, observed 28 with positive signs and 12 with presumptive signs of peptic esophagitis or stricture formation. Similar experiences have been reported by Nissen.[7]

The majority of these cases of inflammatory stenosis can be explained by the action of acid-peptic gastric juice in the lower esophagus. The evidence for such an explanation is the demonstration that gastric juice can gain access to the esophagus and, once in this location, will produce an inflammatory lesion. The erosive effect of gastric juice on the esophagus has been demonstrated by Ferguson and associates[8] and by Wangensteen and Leven.[9] Reflux of gastric content into the esophagus occurs clinically, especially in the presence of gastrointestinal pathology such as gall bladder disease or peptic ulcer.[10, 11] An association of esophagitis and stenosis with conditions allowing the frequent contact of gastric juice with the lower esophagus has been demonstrated.[12-14]

In 1951 Kiriluk and Merendino[15] reported a series of 18 animals in which 50 per cent proximal gastrectomy, including the terminal centimeter of esophagus with restoration of gastrointestinal continuity by esophagogastrostomy, was carried out. Supplementary procedures included pyloromyotomy, pyloroplasty, and preservation of the gastric pouch. Spontaneous complications of esophageal ulcer with perforation and massive hematemesis, or

melena, accounted for 50 per cent of the deaths in the animals in an average of 45.5 days. In a more recent report[16] these same investigators related an experience with 21 dogs subjected to a 50 per cent proximal gastrectomy. In addition to this, ancillary procedures included bilateral vagotomy, gastrojejunostomy, anterior and posterior esophagogastrostomy, "preservation" of the vagi nerves, and the formation of a valvelike esophagogastrostomy. Sixty-two per cent of this series of animals died of spontaneous esophageal complications in an average of 56 days. Of 13 dogs which included 5 from the earlier series, all of which had survived for three or more months postoperatively, only 5 exhibited normal esophagi by esophagoscopy. In this series the creation of a valvelike esophagogastrostomy and the "preservation" of the vagal nerves were the only supplemental procedures which suggested a protective effect in preventing esophageal complications. The valve in this case was of the "fish mouth" type.

METHOD

Regurgitation and belching are common physiologic events in normal men and dogs, and demonstrate that the cardiac mechanism is a reversible one which may be incompetent normally at times. The normal "hiatal valve" depends upon the obliquity of insertion of the esophagus into the stomach wall together with a mechanical arrangement which permits the approximation of the walls of the esophagus by the intragastric pressure which, in the absence of a peristaltic wave traveling down the esophagus, tends to obliterate the stoma and to prevent regurgitation. Thus the concept was formulated that perhaps a plastic procedure on the distal esophagus could be performed which would more nearly approximate the functions of the normal "hiatal valve" than a simple end-to-side or end-to-end esophagogastrostomy.

Healthy, adult mongrel dogs weighing from 30 to 60 pounds were used. Six such animals were subjected to the procedure. Both vagal nerves were preserved. The esophagus was transected 1 cm. above its inosculation into the stomach and the cardia was transected about 1 cm. below. This wound was then closed. Esophagogastrostomy with the formation of a valve was carried out in end-to-side fashion. The technique used is illustrated in the accompanying diagrams (Figs. 1-5). Thus, the esophagogastrostomy in each case lies above the level of the diaphragm in the posterior mediastinum.

EXPERIMENTAL RESULTS

The results are summarized in Table I.

All esophagoscopies were carried out under general anesthesia. Mild esophagitis was indicated by erythema of the mucosa. No ulceration or stenosis was noted in any of the preparations. The dogs ate well. Some, however, did not relish the laboratory diet; the loss of weight in one case is attributed to this.

On April 1, 1954, all the dogs were studied by fluoroscopic examination following the introduction of a barium meal into the upper esophagus. In all cases the barium passed easily through the "hiatal valve" into the thoracic portion of the stomach (Fig. 6). With the animal held at a 90-degree angle with the head downward, a small amount of barium regurgitated into the esophagus. In this case, however, the main mass of the barium was retarded from passing into the esophagus by a marked contraction of the diaphragm (Fig. 7). We have termed this phenomenon "diaphragmatic impedence."

Dog 4 died 118 days following operation. The diaphragmatic wound had been sutured with too fine suture material, and dehiscence occurred with strangulation of small intestine. The specimen shows the end result of the procedure (Figs. 8, 9).

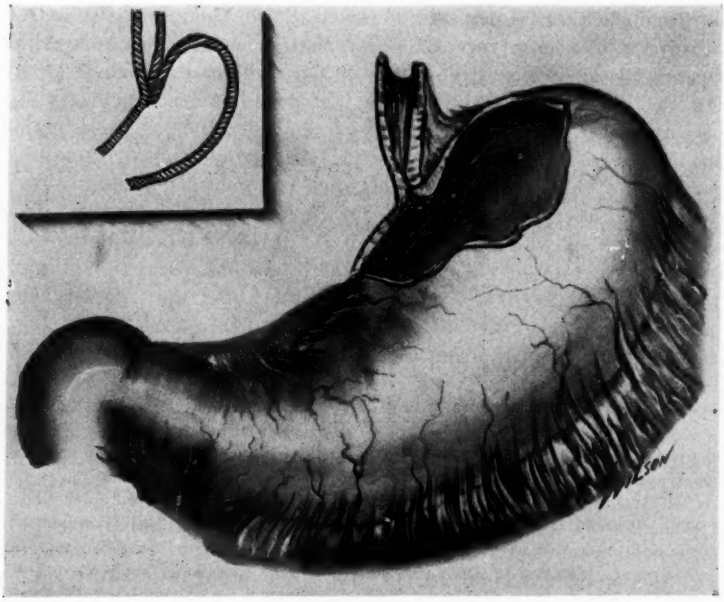

Fig. 1.—The normal cardia is closed by the "hiatal valve." The mucosal lips are approximated by the intragastric pressure which exceeds the intraesophageal pressure.

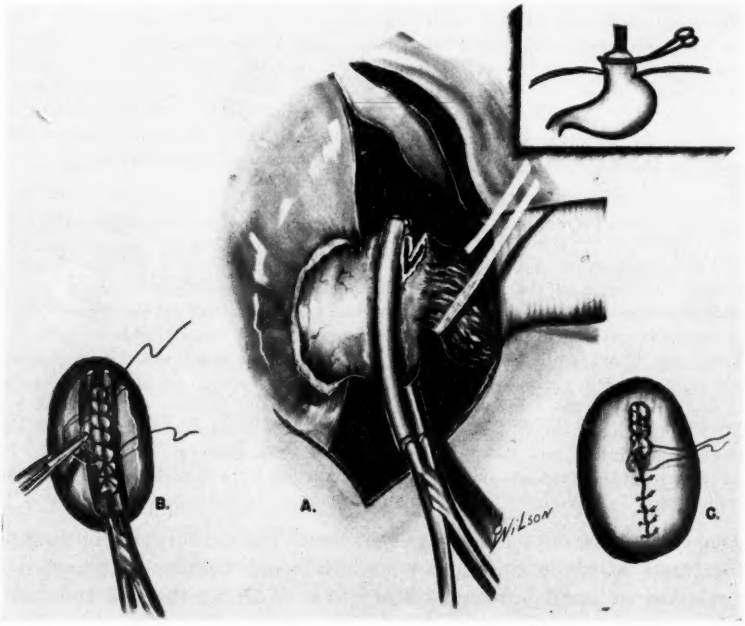

Fig. 2.—*A*, The cardia and the distal 1 cm. of esophagus are excised. *B* and *C*, The cardiac orifice is closed.

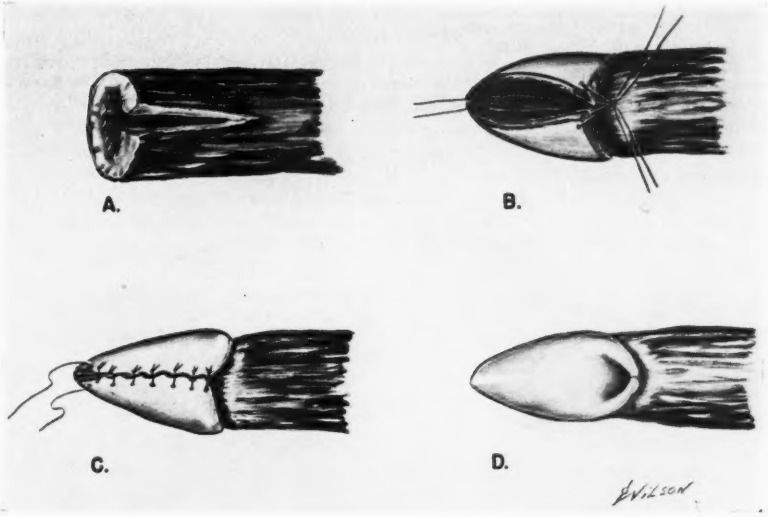

Fig. 3.—*A*, The esophagus is slit for a distance of 3 cm. *B*, *C*, The cut edges are rotated 180° and approximated. *D*, The completed valve is now ready for implantation.

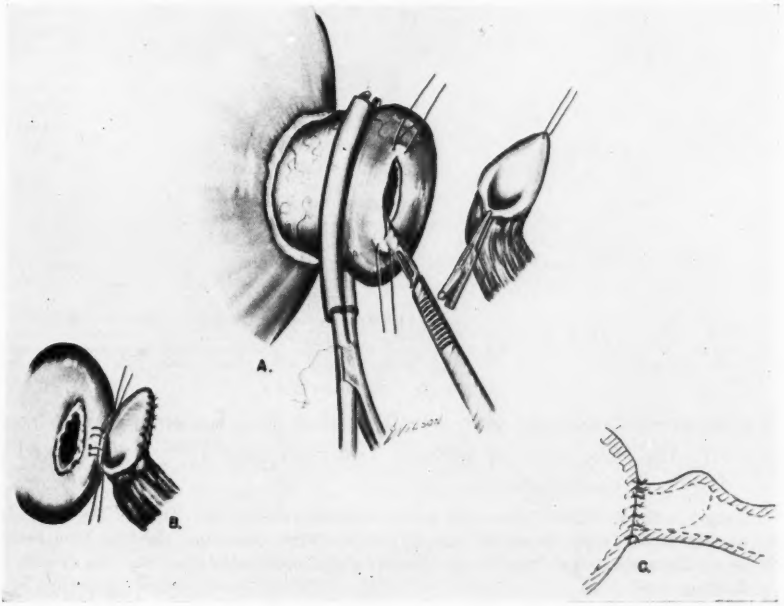

Fig. 4.—*A*, Esophagus with valve is implanted into buttonhole stoma of stomach. *B*, Two rows of sutures are used so that good mucosal approximation results. *C*, Insert shows valve pushed into esophageal lumen to facilitate anastomosis.

TABLE I

DOG NO.	INITIAL WEIGHT (LBS.)	DATE OF OPERATION	IMMEDIATE POST-OPERATIVE STATUS	DATE	RESULTS OF ESOPHAGOSCOPY	FINAL WEIGHTS (LBS.)	SURVIVAL IN DAYS POST-OPERATIVELY
1	45	8/21/53	Vomiting for 3 days	10/ 5/53	Slight esophagitis; moderate reflux		
				12/23/53	No esophagitis; slight reflux		
				2/11/54	Negative		
				4/11/54	Negative	42	234
2	42	9/16/53	Vomiting for 3 days	10/ 5/53	Slight esophagitis; slight reflux		
				12/23/53	Slight esophagitis; slight reflux		
				2/11/54	Slight esophagitis; slight reflux		
				4/11/54	Slight esophagitis; slight reflux	32	208
3	34	10/ 8/53	Vomiting for 3 days	12/23/53	No esophagitis; slight reflux		
				2/11/54	No esophagitis; slight reflux		
				4/11/54	No esophagitis; slight reflux	37	186
4	36	11/20/54	Vomiting for 3 days	12/23/53	Negative		
				2/11/54	Negative	35	118 (died of strangulated traumatic diaphragmatic hernia)
5	30	1/ 4/54	Vomiting for 3 days	2/11/54	Slight esophagitis; moderate reflux		
				4/11/54	Slight esophagitis; moderate reflux	30	98
6	60	2/ 8/54	Vomiting for 3 days	2/24/54	Slight esophagitis; moderate reflux		
				4/11/54	No esophagitis; slight reflux	55	63

CLINICAL APPLICATION

Because of the encouraging results derived from the animal experiments, essentially the same type of valvular esophagogastrostomy was carried out in the following clinical cases.

CASE 1.—E. F. M., a 68-year-old white woman, entered the hospital Sept. 24, 1953, with complaint of dysphagia since January, 1953. Since that time she had been troubled with regurgitation and had lost 70 pounds. At the time of admission she was able to take only liquids.

Examination demonstrated a chronically ill woman with marked evidences of profound weight loss. She was moderately dehydrated. Her blood pressure was 140/86, pulse 88, respirations 22. The liver edge was palpable 5 fingerbreadths below the costal margin.

Urinalysis was negative except for a few granular casts. Examination of the blood showed the hemoglobin to be 13 Gm. The erythrocyte count was 4.6 million. The leukocyte count was 7,900 with a normal differential count.

Esophagoscopy demonstrated a lesion 2.5 cm. above the cardia, and examination of tissue removed by biopsy showed adenocarcinoma of the stomach with extension to the esophagus. Operation was carried out Oct. 30, 1953. A left posterolateral thoracotomy incision was made removing the eighth rib subperiosteally. A large, very fixed, hard mass involving the proximal four-fifths of the stomach was found; obvious metastases to the gastrosplenic lymph nodes and the left gastric pedicle were present. The esophagus was mobilized by incising the mediastinal pleura up to the inferior pulmonary vein. The left gastroepiploic vessels were ligated and the spleen was mobilized and removed. The stomach was mobilized along the greater and lesser curvatures to the duodenum. The

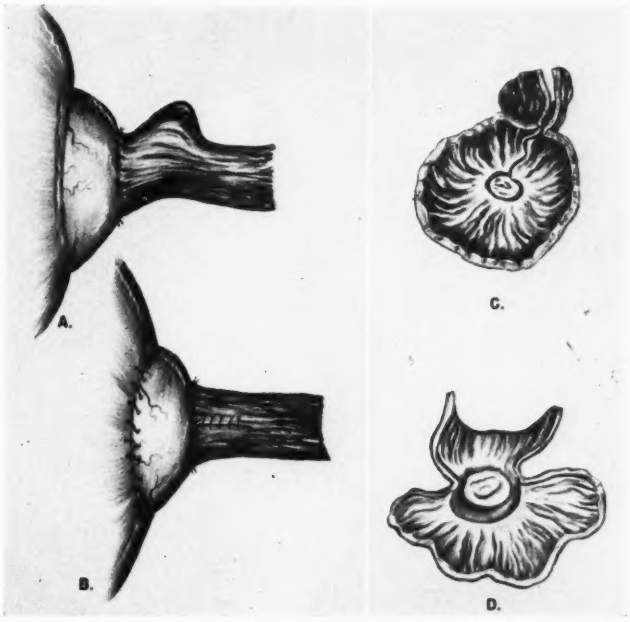

Fig. 5.—*A*, If necessary, the valve may be pushed into the lumen of the esophagus to facilitate suturing. *B*, Then the valve is pushed into stomach using a small slit in the esophagus which is then sutured. *C*, Upon completion of the procedure the valve almost completely occludes the stoma in the resting esophagus. *D*, The protruding mushroom of the valve is shown.

stomach was transected obliquely in its distal portion allowing a considerable part of the lesser curvature to remain. The esophagus was next transected, leaving a margin of 3 inches above the gross proximal extent of the tumor. A valvular esophagogastrostomy of the type described was carried out, implanting the esophagus into the distal gastric pouch by removing a button of gastric wall and anastomosing the esophagus to the stomach. The gastric pouch was fastened to the parietal pleura with interrupted sutures.

Her postoperative course was very satisfactory. She was able to swallow satisfactorily and could take solid food with no difficulty. During the immediate postoperative period she had mild diarrhea which was easily controlled by bismuth and paregoric. In spite of the fact that an incomplete resection of the malignancy had been carried out, she had no further difficulty with regurgitation or dysphagia.

An upper gastrointestinal series Nov. 23, 1953, showed a nicely functioning valvular anastomosis with an artificial hiatus hernia (Figs. 10 and 11). There was no appreciable reflux back into the esophagus in the recumbent Trendelenburg position. Following her dismissal from the hospital she got along reasonably well, but failed to gain weight. Repeated esophagoscopies failed to show evidence of esophagitis.

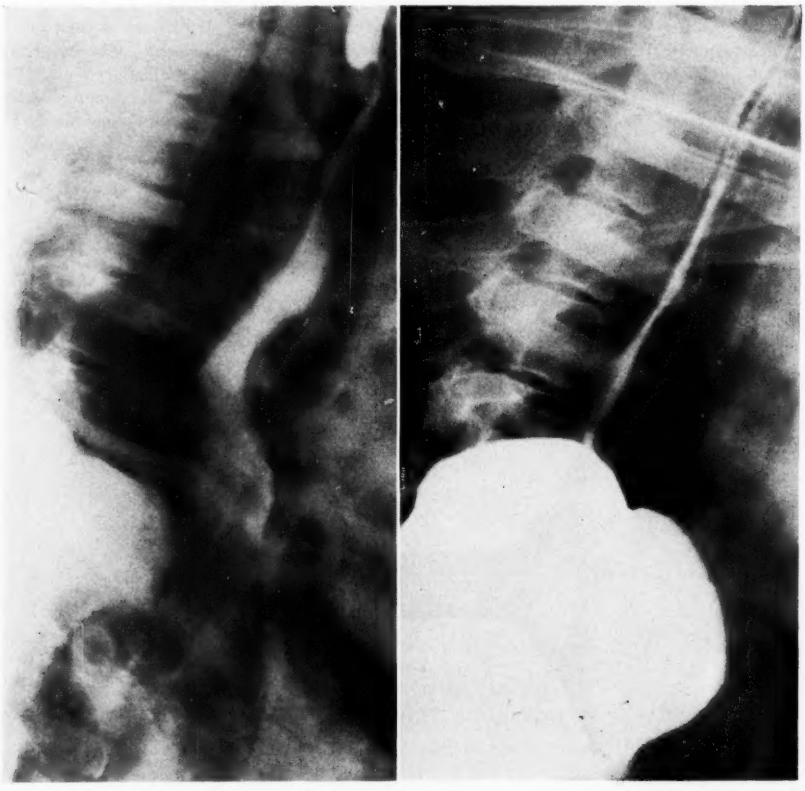

Fig. 6. Fig. 7.

Fig. 6.—Roentgenogram shows the valve at the junction of esophagus and intrathoracic portion of the dog's stomach.

Fig. 7.—Roentgenogram of dog held head downward following ingestion of barium meal. Little barium regurgitates into the esophagus; most of it is held back by "diaphragmatic impedance."

CASE 2.—J. J. J., a 68-year-old white man, entered the hospital on Sept. 2, 1953, with the complaint of dyspnea for four years and regurgitation of food for one month. He had developed a progressive increase in dyspnea during the preceding month and had periodic precordial pain. During the preceding month he had been unable to swallow any solids, and upon admission he was unable to take even water.

Examination disclosed a poorly nourished white man in respiratory distress and appearing chronically ill. Blood pressure was 95/75; pulse 88, respirations 44 and irregular. The neck veins were distended. Examination of the chest showed a marked increase in the anteroposterior diameter. The lungs were hyperresonant and the breath sounds were

decreased in intensity. A systolic murmur was present over the apex. P_2 was greater than A_2. The liver extended 4 cm. below the costal margin and was not tender.

The urinalysis was negative on admission. Examination of the blood demonstrated a hemoglobin of 16 Gm.; the white blood count was 13,600 with a normal differential count. Total blood proteins and the albumin-globulin ratio were normal. The serology was nega-

Fig. 8.

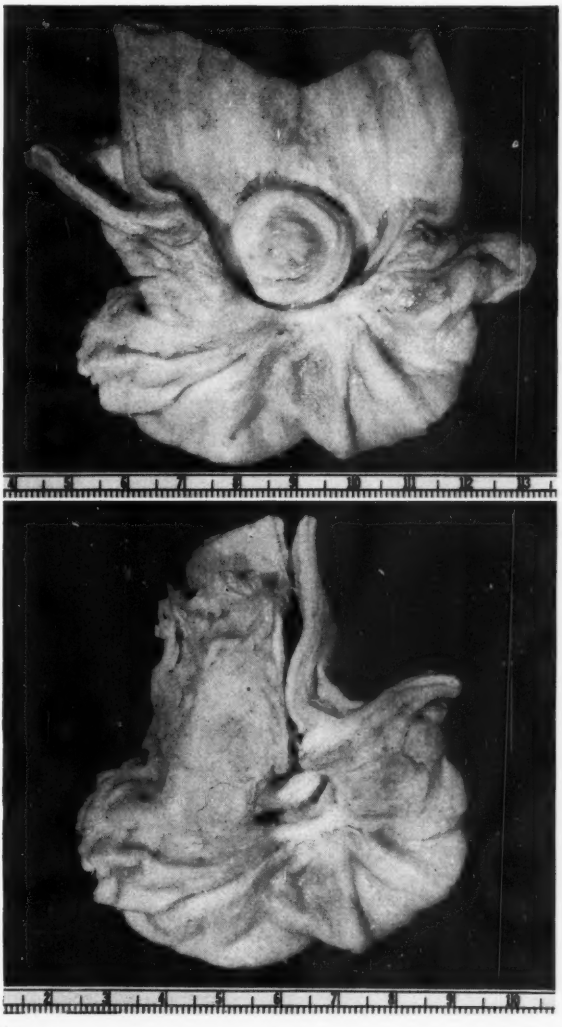

Fig. 9.

Fig. 8.—Specimen shows inosculation of esophagus into stomach. There is no evidence of esophagitis. The mushroom projection of the valve is seen.

Fig. 9.—When the edges of the cut esophagus are approximated the valve is seen to almost completely occlude the stoma.

Fig. 10.

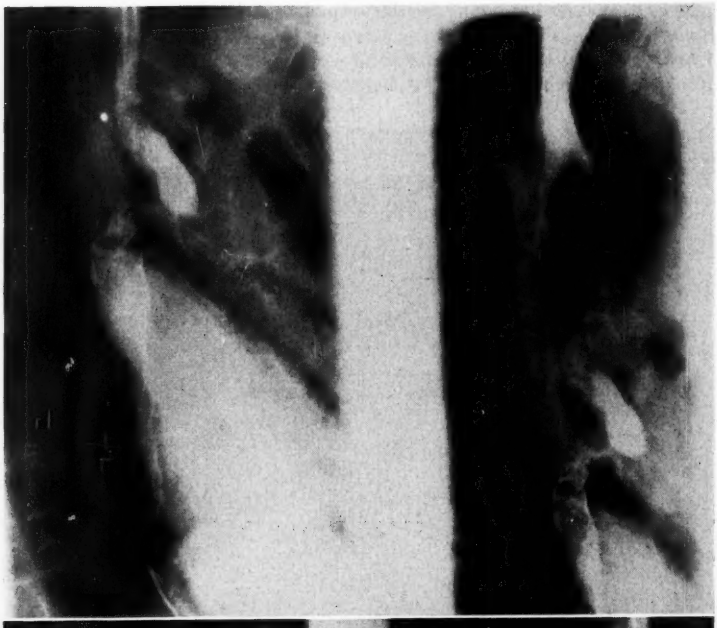

Fig. 11.

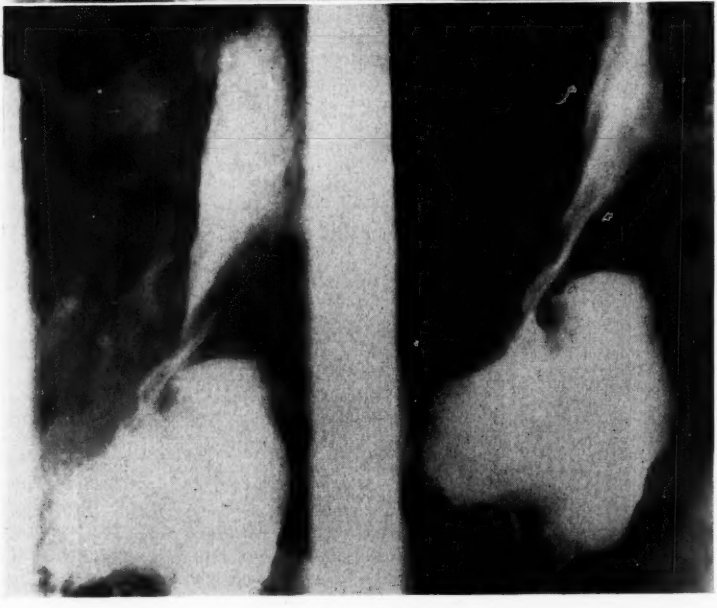

Fig. 10.—E.F.M. The esophagus enters the stomach via a valvular mechanism.
Fig. 11.—E.F.M. The artificial "hiatal valve" is seen to open when a peristaltic wave carrying a barium bolus arrives at the stomach.

tive. An electrocardiogram showed a normal sinus rhythm with marked clockwise rotation consistent with cor pulmonale. A roentgenogram of the esophagus showed a marked obstruction in the esophagus at a point 18 cm. proximal to the cardia. This obstruction was seen to be irregular and extended over an area of approximately 8 cm. of the lower half of the esophagus.

Esophagoscopy on September 8 demonstrated an obstruction in the middle third of the esophagus. The obstruction consisted of globular pedunculated growths producing almost complete obstruction. Microscopic examination of tissue removed for biopsy demonstrated a squamous cell carcinoma of the esophagus.

Operation was carried out on Sept. 23, 1953. In spite of the fact that the patient had severe pulmonary emphysema and arteriosclerotic heart disease requiring digitalis, it was felt that exploratory thoracotomy should be undertaken.

A left thoracotomy was performed through the bed of the eighth rib. The lung showed chronic fibrosis with a few scattered subpleural blebs. The posterior mediastinum was opened and a cancer of the esophagus measuring 10 cm. in length and fixed markedly in the posterior mediastinum was demonstrated. The esophagus was freed from the pulmonary hili. The lesion extended so high that transection above the aorta was mandatory. Because it was impossible to remove all of the involved esophageal nodes bilaterally, this procedure was considered to be only a palliative operation, justified by the absolute dysphagia. The diaphragm was opened from the esophageal hiatus outward through the central tendon, and the stomach was mobilized along the greater and lesser curvatures, ligating the left gastric and left gastroepiploic vessels, but leaving the spleen intact. The esophagus was cut across at the cardia approximately 6 cm. below the palpable lower edge of the lesion, and the cardia was closed. The stomach was sufficiently mobilized so that it could be easily drawn up into the left hemithorax. The esophagus was transected at a point 4 cm. above the superior edge of the lesion and removed. The posterior border of the esophagus was incised for a distance of 3 cm., and a valve was constructed, approximating the edges posteriorly with interrupted sutures so that the distal portion of the esophagus to be anastomosed into the side of the stomach had an introitus diagonal in direction and considerably smaller than the full lumen of the esophagus. Esophagogastrostomy was then carried out, approximating the mucosa of the esophagus and stomach. A plastic tube was threaded through the anastomosis, well into the stomach, and the stomach was fixed to the thoracic wall with interrupted silk sutures. The diaphragm was reconstructed and the chest wall closed in layers.

Comment.—The applicability of this procedure is illustrated by these two cases. In the first case the lesion was situated in the cardiac portion of the stomach and in the lower third of the esophagus. It is in this group of cases of esophagogastric anastomoses (esophagogastrostomy, cardioplasty, etc.) that so many poor results have occurred.

In the second case the lesion was situated in the midportion of the esophagus, and anastomosis was required above the level of the aortic arch. The procedure of valvular esophagogastrostomy was easily carried out in this case.

DISCUSSION

Valdoni[17] has demonstrated the worth of a valvular type of esophagogastrostomy in high anastomoses. In his cases the resections of the stomach and esophagus were carried out by a preliminary supraumbilical median laparotomy followed by a right thoracotomy. After the stomach pouch had been drawn up into the right hemithorax, a terminolateral anastomosis was made between esophagus and stomach. Thus, the long axis of the esophagus

was oblique with respect to the long axis of the displaced stomach. In this procedure, then, one component of the "hiatal valve," the oblique inosculation of the esophagus into the stomach, is utilized. However, this procedure is restricted to high esophageal resections with the stomach being placed in the right hemithorax. It cannot be applied to lesions in the lower third.

The normal mechanism to prevent the regurgitation of food into the esophagus is a valvular one situated at the cardiac orifice and called the "hiatal valve." The two components of this valve are the oblique inosculation of the esophagus into the stomach and the difference in intraluminal pressures of the two viscera which approximates the mucosal lips of the cardia. Our procedure imitates these features of the normal cardiac orifice. Further, in the normal person with deep inspiration, the descending diaphragm increases the angle of entry of the esophagus into the stomach as well as increasing the intragastric pressure. These factors would tend to decrease the competence of the valve. However, in this circumstance the "diaphragmatic pinchcock" affords an additional hindrance to regurgitation. This is produced normally by the right crus of the diaphragm. In our dogs and patients operated upon this same effect which we have called "diaphragmatic impedance" occurs.

The efficiency of our valvular anastomosis has been demonstrated by repeated observations of our experimental animals and patients. Further, the ease and applicability of this procedure to both high and low esophagogastrostomy are of considerable advantage.

Although this communication must necessarily be a preliminary report, and although we have restricted the use of the procedure so far to cases of proved malignancy, it is our hope that it may find more extensive use in being applied to benign lesions of the esophagus, especially those occurring in the lower third. We hope that it may find application to cases of peptic ulceration and stenosis of the lower third of the esophagus associated with short esophagus and hiatal hernia.

CONCLUSIONS

1. Valvular esophagogastrostomies were carried out in dogs in which the entire stomach pouch was preserved.

2. These dogs have survived without evidences of appreciable esophagitis for periods varying from 63 to 234 days, and were still living at the time of this report.

3. This procedure has been carried out in human patients with encouraging clinical and roentgenologic results. It has the advantage of being applicable to both high and low esophagogastrostomies.

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DISCUSSION

DR. ALFRED HURWITZ, West Haven, Conn.—I should like to compliment Dr. Watkins and his group on their ingenious method of constructing esophageal valves. I think they will have to have a long follow-up of these patients, however, before they will be able to determine whether they can emulate the intricacies of Nature so far as the construction of valves in this region is concerned.

With regard to the type of anastomosis, we have felt that esophagojejunostomy offers much more than esophagogastrostomy in the prevention of the factor of acid regurgitation. I think we are all agreed that acid regurgitation is the *bête noire* in the problem that faces us, viz., the development of esophagitis and later stenosis. We have had gratifying experiences with nine patients who have had esophagojejunostomy, experiences that have been described in the past by Allison of Leeds and Barnes at the New York Hospital. Two of the patients are living for five and seven years after operation, are completely well, and are able to ingest at one sitting as much as any average adult male.

Two patients have had an anastomosis by an end-to-side esophagojejunostomy with an enteroenterostomy. One patient had had a splenectomy in 1946 for a Banti syndrome complicated by esophageal varices which were bleeding markedly at that time. In 1952, because of recurrent bleeding, I performed a portocaval anastomosis which gave him a remission for one year, followed by two bouts of severe bleeding. Approximately six months ago, through a left thoracoabdominal incision, the pressure was determined in the gastroepiploic veins and found to be 180 mm. of saline. The lower 3 inches of the esophagus plus the upper third of the stomach were resected; the gastric pouch was closed and left behind. Whether we should have done a pylorotomy remains to be seen, but it was not done at the time. A Roux en-Y anastomosis was performed. We feel that this procedure has three advantages so far as treatment of esophageal varices is concerned. First, the area which is most vulnerable to acid digestion and in which the varices usually bleed has been removed. Second, the acidity is cut down both by the bilateral vagectomy and removal of a good portion of the proximal part of the stomach. Third, the en-Y anastomosis should help prevent regurgitation into the esophagus. I feel that this may be ap-

plied not only as a secondary procedure in cases where shunts have failed, but possibly as a primary procedure where it has been determined that the factor of acid digestion is more prominent than the degree of portal hypertension.

DR. JOHN H. GARLOCK, New York, N. Y.—I want to congratulate the authors on this rather ingenious procedure. It may turn out to be the answer to some of the difficulties we encounter following resections for benign lesions of the lower esophagus. I would like to emphasize that it is important to make a very sharp distinction between esophagogastric resections for malignancy and benign lesions, especially strictures following esophagitis. In this connection, may I call your attention to some physiologic studies which were made on my service at Mt. Sinai Hospital by Dr. Dreiling, Dr. Druckerman, and Dr. Hollander on the secretory function of the stomach and pancreas following radical resection for carcinoma of the esophagus and cardia. Their paper was published two years ago in GASTROENTEROLOGY.

They studied ten patients taken at random from a large group that had had radical resections for malignant neoplasm. It is interesting to note that in every instance but one there was complete anacidity. The one exception, a patient who had had a carcinoma of the middle third of the esophagus, showed a combined acid figure of 42 units. After the Hollander insulin test it was found to be zero. It is important to differentiate this group of patients from those who have reflux esophagitis following resection for benign lesions. We have not been bothered in any way by reflux esophagitis in the carcinoma group. When stricture developed at the anastomosis in the early days of our experience, it was found to be due to the use of a continuous suture in making the anastomosis. This complication has been obviated since interrupted sutures were introduced. Latterly, our experience has been that, when a stricture develops at or near the suture line, it has been found to be caused by a recurrence either at the suture line or in the posterior mediastinum. Further experience and prolonged follow-up will settle the efficacy of this new procedure. I would hazard the guess that this newly created valve will undergo scar contraction as time goes on, and that its function will decrease the longer the patient is followed.

DR. DENTON A. COOLEY, Houston, Texas.—We, like many others, have been impressed with the difficult problem of erosive esophagitis which occurs after esophagogastric anastomosis. The bleeding and obstructive symptoms in such cases may lead to an entirely unsatisfactory result of an operation which was otherwise curative for the original lesion. The solution of this problem is vital if esophageal resection is to be employed more frequently and for benign as well as for malignant diseases. Dr. Watkins' presentation of a technical modification in the method of anastomosis is interesting in this regard, but I doubt whether it will appreciably alter the situation particularly for anastomoses performed in the lower third of the esophagus. Personally, I believe that the problem in the distal esophagus will be the same at the junction of acid-secreting gastric mucosa with squamous epithelium, regardless of the attempts to reproduce a valvular mechanism at the anastomosis.

During the past three years we have advocated extensive subtotal esophagectomy for practically all esophageal lesions irrespective of their anatomic level, and have reported on the results of this method of treatment.* The rationale for this apparently radical attitude is based upon the clinical observation that postoperative esophagitis in the high anastomosis is very infrequent. We have used this procedure for carcinoma, lye stricture, stricture from peptic esophagitis, and for extensive varices, and no instance of postoperative esophagitis has been encountered. Jejunal transplants are, we feel, unsafe, and, as already mentioned here today, there are certain late complications which make esophagojejunostomy undesirable. When the stomach is transplanted into the thorax, gastric drainage can be improved by concomitant pyloromyotomy and should be used routinely. Restora-

*Dr. Denton A. Cooley: Palliative Resection for Carcinoma of the Esophagus, A.M.A. Arch. Surg. **66**: 781, 1953; Subtotal Esophagectomy for Bleeding Esophageal Varices, A.M.A. Arch. Surg. **68**: 854-871, 1954.

tion of alimentary continuity with the normal progression of food and juices from esophagus to stomach to intestine is thus achieved without the complications of treatment associated with other methods.

DR. HERBERT W. SCHMIDT, Rochester, Minn.—The marked reduction in mortality rates in thoracic surgical procedures has broadened the indications for operations on the esophagus. An increasing number of operations are now being performed for lesions that involve the cardia. Many of these lesions require excision of the cardia, and this always causes an incompetency which allows free regurgitation of gastric contents into the distal part of the esophagus. This condition at times produces peptic esophagitis and ulceration.

Anything that can be done to prevent such a complication would be most worth while. It will be interesting to see whether or not the procedure that Dr. Watkins has described will completely solve this problem. It will take time to be certain about this, because the development of peptic ulceration may be slow. Sometimes up to eighteen months may elapse before it becomes manifest.

DR. PAUL NEMIR, JR., Philadelphia, Pa.—I have enjoyed Dr. Watkins' paper very much. I would like to bring up one factor concerned with esophagitis following destruction of the esophagogastric junction mechanism which has not received a great deal of attention. This factor was strikingly demonstrated in two patients who had achalasia of the esophagus of long duration. In both, conservative management was ineffective in relieving the symptoms, and operation was therefore performed. One of these was operated upon in 1948 and an esophagogastrostomy of the Grondahl type was performed. The other was operated upon in 1950 and an esophagocardiomyotomy was performed. Postoperatively, both developed severe esophagitis, and on several occasions had severe hemorrhages. Both patients had no free acid on gastric analysis. On barium swallow, both patients exhibited no delay in emptying at the esophagogastric junction, but marked delay in emptying at the pyloroduodenal area. Very little barium was found to leave the stomach even up to six hours. Both had marked regurgitation from the stomach into the esophagus when placed in the Trendelenburg position on the fluoroscopic table. In one of the two, it was thought that a stenosing duodenal ulcer was accounting for the delayed emptying. Operation was again performed on both patients. No duodenal ulcer was found nor was there any gross evidence to account for the delayed emptying at the gastroduodenal area in either case. A gastrojejunostomy was performed in one, and a subtotal gastrectomy in the other. Postoperatively, both were completely relieved of their symptoms and gastric emptying was no longer delayed. There have been no further hemorrhages. I think in addition to the acid peptic factor, the factor of delay or failure of normal emptying at the gastroduodenal area and the resultant regurgitation are also contributing causes to the esophagitis. In these two cases, despite no free gastric acid, there occurred severe esophagitis and hemorrhage, which was relieved by improving the gastric emptying.

The delay in gastric emptying is difficult to explain. It is highly unlikely that the vagus nerves were severed in either procedure. We carefully examined the resected specimen of stomach and no gross disease was found at the pyloroduodenal area. The intrinsic neural plexus was present. As postulated with the esophagus, however, it may be that there is a generalized derangement of function of the intrinsic neural mechanism, without necessarily an absence, in this disease.

DR. I. DARIN PUPPEL, Columbus, Ohio.—Dr. David Watkins and his group are certainly to be congratulated for this splendid piece of experimental and clinical work. We have been interested in the difficult problem of bleeding esophagitis for a number of years. Recently Dr. Robin Obetz, Columbus, Ohio, and I had a patient 60 years old with severe bleeding esophagitis, and an associated sliding hiatal hernia, a severe anemia with a red cell count of 2.5 million and a hemoglobin content of 6.9 Gm. per cent. This patient is well and shows no evidence of bleeding following a transthoracic transplantation operation in which we imbricated the diaphragm in back and in front of the esophagus, thus taking the lower esophagus through an oblique tunnel of diaphragm for about an inch.

This tunnel seemingly acts as a sphincter, and no evidence of regurgitation or dysphagia has as yet been discerned. In the Trendelenburg position barium does not regurgitate from the stomach into the esophagus postoperatively. The red cell count is now 4.2 million and the hemoglobin 13.1 Gm. per cent.

For one case of bleeding esophagitis which occurred following an esophagogastrostomy with vagotomy and partial gastric sympathectomy, I did a posterior gastrojejunostomy two years later. This procedure led to better gastric drainage and also allowed mixture and neutralization of the acid gastric secretions by the alkaline secretions of the liver and pancreas. In this case bleeding has not as yet occurred following the gastrojejunostomy.

DR. J. L. EHRENHAFT, Iowa City, Iowa.—In the very occasional patient in whom one prefers to prevent regurgitation esophagitis or in whom a lower esophagectomy or total gastrectomy would be necessary, I believe a direct esophagoduodenostomy following total gastrectomy is a wise procedure. This end-to-end esophagoduodenostomy in some selected patients is feasible if the approach is through a left combined thoracoabdominal incision. Our experience with this is limited, but we were surprised at the ease with which a good end-to-end anastomosis between esophagus and duodenum can be established. This reduces the operating time considerably, does away with Roux en-Y or loop esophagojejunostomies and also establishes a more physiologic gastrointestinal continuity.

DR. DAVID H. WATKINS (Closing).—I wish to thank the discussors for their remarks. With regard to Dr. Cooley's comment, if you do not have the esophagus you do not have peptic ulcer in the esophagus. Valdoni and others have shown over a period of some years that in the high gastroesophageal anastomosis, esophagitis is not a problem. He did his cases with a preliminary median supraumbilical laparotomy and then a right posterolateral thoracic incision. He attributed the good results in his cases to the fact that a type of valve was formed in the esophagogastrostomy which was done at this time. I think we must emphasize that this procedure is designed only for those cases in which it is desired to preserve stomach function. I personally always have had a deep attachment for that organ, particularly with regard to its function.

There is another possibility in those cases which require a total gastrectomy and the removal of a variable amount of the esophagus. In our hands, at least, the best functional results have come from the use of a transplant of colon from the transverse and descending colon, essentially according to a plan which was devised in 1908 by Dr. Archibald, who demonstrated that the colon blood supply could be maintained if only one of the radial colon arteries is preserved along with the marginal vessels. I think in cases in which total gastrectomy is done that this is the proper procedure..

OPPORTUNITIES FOR RESEARCH IN THORACIC SURGERY WITH THE USE OF TISSUE CULTURE METHODS

C. M. Pomerat, Ph.D. (by invitation)*
Galveston, Texas

As indicated by its title, this report is directed at suggesting some of the many opportunities for research on the dynamic cytology of tissues found in the chest which are available with modern methods for cell culture. No fundamental questions will be resolved. Analyses of pathologic mechanisms will be touched upon only by means of a few citations from the literature and with a group of photomicrographs. The main evidence for the approach consists of a group of phase contrast, time lapse cinematographic sequences showing the activities of cells derived from the respiratory system of man. In short, the lecture represented by this paper consisted only of an invitation to research with the methods described.

MATERIALS AND METHODS

Workers in laboratories having facilities for cell culture as applied to problems of experimental medicine generally find it valuable to use a wide variety of methods. For the rapid screening of new drugs in the determination of toxicity, the use of small hanging drop-slide preparations has been found particularly valuable.[1] Such preparations are also useful for short-term cultures of adult human epidermis[2] and nasal mucosa.[3] Epithelial outgrowth is favored by the addition of 3 to 4 drops of cell-free ascitic fluid of malignant origin onto an avian plasma clot containing the tissue explant. Maximow's double cover-slip method for the cultivation of explants from surgical specimens has been described by Murray.[4] Carrel flask technique and its modification by Porter recently have been outlined by White.[5] Perhaps of widest general use is the roller-tube method of Gey.[6] In our own experience the arrangement of several explants on the outer face of double cover glasses in roller tubes[7] has proved especially useful for many types of experiments.

Excellent reviews are available concerning the suitability of various media and the rules for the replenishment of nutrients, the latest of which can be found in White's book.[5] As an outgrowth of studies on the behavior of cell sediments in body fluids, our group has made extensive use of ascitic fluid, both malignant and nonmalignant in origin, as a medium constituent.[8] However, with the increased use of mercurial diuretics, the supply not only has become less available, but its chemistry is likely to be complicated. For those who favor the presence of human proteins in the fluid nutrient phase, human umbilical cord serum unquestionably remains the object of choice when an adequate quantity readily can be obtained.

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Read at the Thirty-fourth Annual Meeting of The American Association for Thoracic Surgery at Montreal, Quebec, May 3 to 5, 1954.

*From the Tissue Culture Laboratory, The University of Texas Medical Branch, Galveston, Texas.

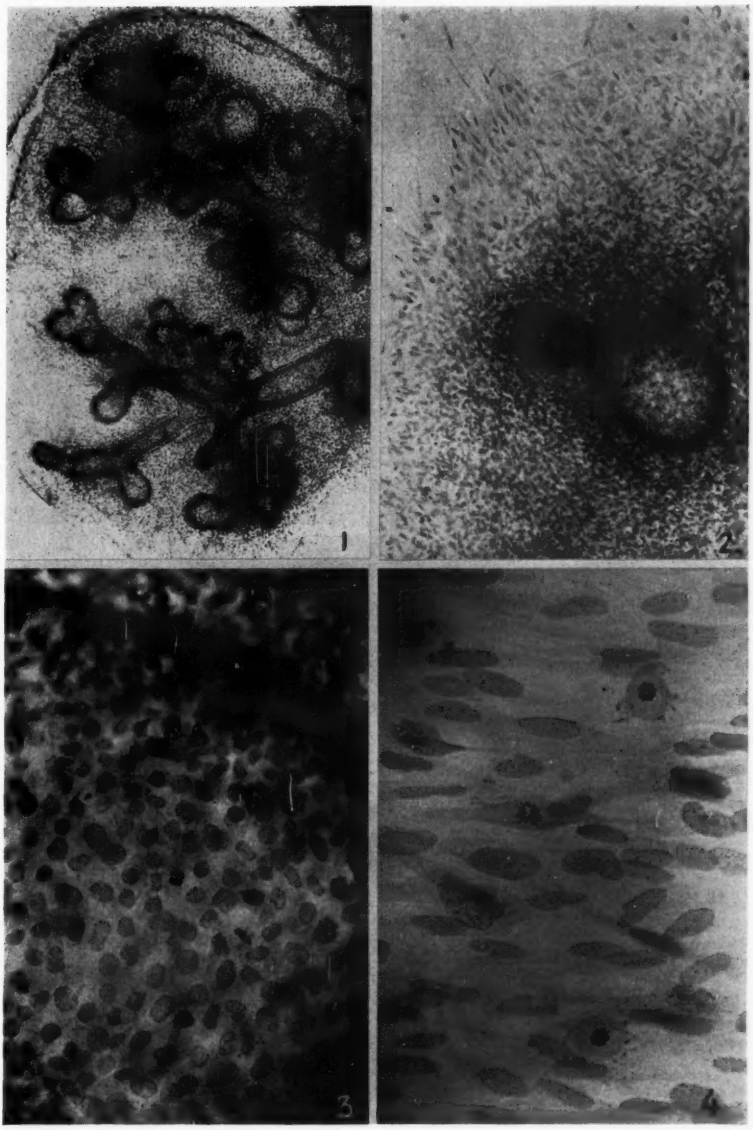
Staining procedures which have proved important in the study of culture preparations include diluted Delafield's hematoxylin, Jacobson's method,[9] Rio-Hortega's double silver impregnation for reticular fibers and Polak's silver method for mitochondria.

The basic arrangement for a double camera assembly used in making phase contrast, time lapse cinematographic records, together with a device for perfusion of cultures, has been described.[10] Cell activities and suggestions for their analysis from film records have been reported by Pomerat[11] and by Pomerat, Lefeber, and Smith.[12]

OBSERVATIONS

Fetal Tissue.—The factors involved in the differentiation of the respiratory tree, including the forces which ultimately arrest its successive branchings, and the determination of the final form of its epithelium, including the vexatious question of the character of the alveolar wall, are among the many unsolved problems of pulmonary histogenesis. Tissue cultures of human fetal lung provide very attractive objects of experimental analyses of these questions. After three days of incubation an explant of lung from a three-month human fetus (Fig. 1) revealed the pattern of saccular terminal buds. While the epithelial components of the system remained in position, connective tissue elements showed rapid peripheral emigration as spindle and phagocytic wandering cells (Fig. 2). Mitotic figures were frequent (Figs. 3 and 4). The cut ends of bronchioles often appeared to have become sealed, primarily as a result of epithelial activity. Similarly, buds isolated in the cutting of explants rapidly became closed systems in fields of mesenchymatous elements (Fig. 2), a propensity possibly involved in mucoviscidosis.

While engaged in experiments designed with other goals in mind, a series of lung cultures was allowed to develop at both room and incubator temperatures. After thirty days at 37° C. the epithelium was represented only by pyknotic nuclei in terminal sacs, while the pattern of the bronchi was clearly defined by spindle cells (Fig. 5). In contrast, cultures maintained for forty-five days at 27° C. retained a conspicuous epithelial system but with a marked tendency for the isolation of cystic bodies (Fig. 6). Experiments paralleling these observations were performed with explants of the testes of newborn rats. Residence for twenty-four days at 37° C. produced cultures in which the seminiferous tubules were of very small diameter and generally widely separated by cells believed to be connective tissue derivatives (Fig. 7). Corresponding cultures exposed to 27° C. for the same period of time not only showed reduction of spindle elements, but the coalescing of the epithelium from the tubules to form a continuous plate of cells. Evidence of the contributions of individual seminiferous tubules was indicated by the scalloped margin of the epithelial sheet (Fig. 8). Consultation of the cross-indexed bibliography of the research in tissue culture by Murray and Kopech[13] reveals several important references dealing with the effect of temperatures, hydrogen-ion concentration, and other variables on the differential growth of epithelial versus connective tissue elements. Fruitful inroads might be made



Figs. 1, 2, 3, and 4.—The appearance of a typical culture of lung tissue from a 3-month-old human fetus after three days of incubation. Stained with Delafield's hematoxylin. Fig. 1, Branching bronchiolar systems with terminal buds. Note the emigration of mesenchymal derivatives. Fig. 2, An isolated epithelial bud which has become sealed to form a cystic body in a field of outwandering connective tissue elements. Fig. 3, The epithelium of a saccular terminal bud showing two mitotic figures. Fig. 4, Spindle elements in the outgrowth showing numerous mitoses.

Figs. 5 and 6.—Sister cultures of lung from a 3-month-old human fetus stained with Delafield's hematoxylin. Fig. 5, Appearance of a culture after incubation at 37° C. for thirty days. Note the destruction of the epithelial components and the persistence of the bronchiolar framework of connective tissue elements. Fig. 6, Culture maintained at 27° C. for forty-five days showing the persistence of epithelial elements. Note the frequency of isolated cystic masses.

Figs. 7 and 8.—Sister cultures of the testis of a newborn rat in vitro for twenty-four days. This experiment was used to extend the observation made on lung tissue regarding the effect of temperature on the persistence of epithelium in vitro. Both preparations were stained with Delafield's hematoxylin. Fig. 7, Relative increase in cells of connective tissue origin at the expense of the seminiferous epithelium in cultures maintained at 37° C. Fig. 8, Confluence of epithelium in the form of a plate with a scalloped margin suggesting the contribution of individual seminiferous tubules and a corresponding decrease in spindle cells from a culture maintained at 27° C.

toward explaining congenital abnormalities of the respiratory system with the use of human fetal lung material cultivated under the highly controllable conditions afforded by available methods.

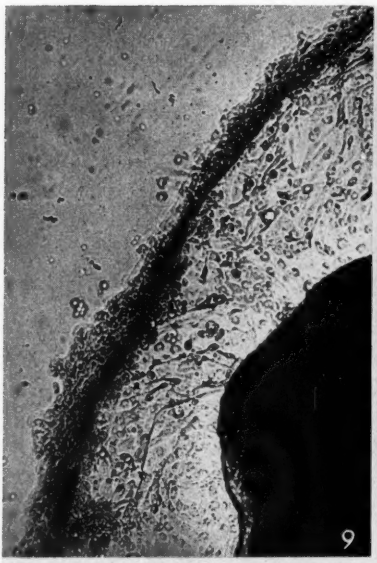
Surgical Specimens.—It is obvious that tissue specimens obtained in the course of the surgical activities of an average-sized hospital can provide an enormous amount of material for culture. Tonsillar tissue discarded from one child can be used in the preparation of several hundred explants. In addition to the study of the pathologic process per se, a given specimen usually can provide a large amount of relatively normal tissue. Thus, a useful deposit of cultures can be prepared as a by-product of pneumonectomies which can be used for basic studies including experimental infections and the induction of neoplasms.

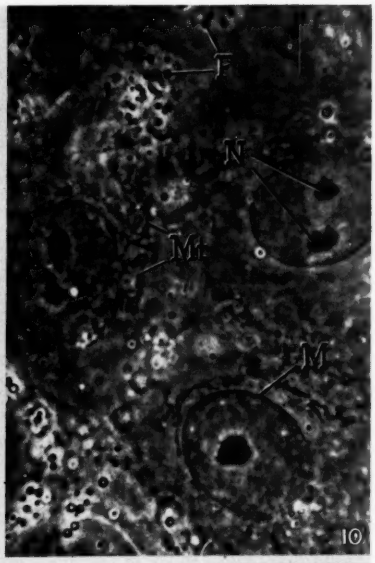
Of special interest is the opportunity of cultivating tissues obtained by bronchioscopic biopsies. Fig. 9 shows a four-day outgrowth of epithelial cells from the bronchial lining of the right lower lobe of a 72-year-old white man (WmBe—JSH 6639 I) with a diagnosis of intrinsic bronchial asthma and compensatory emphysema, who had had a rectal resection for papillary adenocarcinoma two years earlier. The appearance of the nucleoli (*N*), nuclear membrane (*M*), mitochondria (*Mt*) and of fatty droplets (*F*) in living cells photographed with phase microscopy are shown in Fig. 10. Two mitochondrial patterns as revealed with the silver carbonate method are represented in Figs. 11 and 12.* While final results from this study are not yet available, the illustrations are presented as suggestions of the type of study objects not generally available for clinicopathologic study which might prove of special merit.

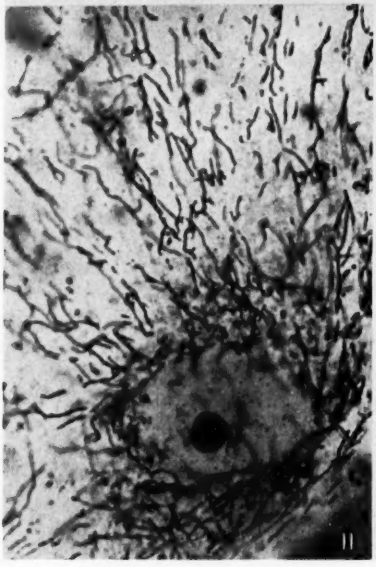
Cultures of Biopsies From the Nasal Mucosa.—This topic deserves special treatment, since it forms a very important area of investigation in our research program and because the essential findings obtained thus far may be applicable to areas deeper within the respiratory tree.

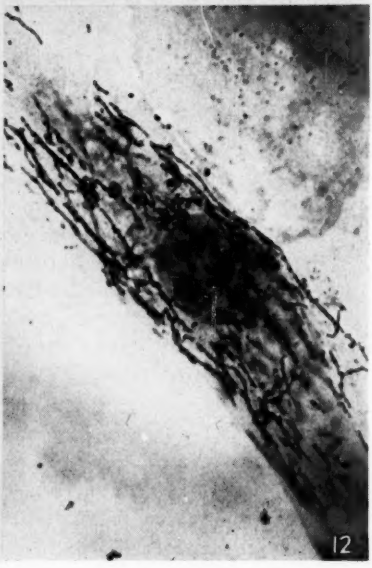
Both simple hanging-drop and roller-tube techniques have been used for the development of short-term epithelial cultures of unanesthetized biopsy material. Specimens derived from the posterior portion of the middle turbinate provide outgrowths of cells which show ciliary motion for approximately two weeks.[3] Suggestions regarding the opportunities afforded by such preparations for the study of allergy have been outlined by Pomerat.[10, 14] While specimens can be readily obtained from subjects with well-studied clinical manifestations of hypersensitiveness and while the use of perfusion chamber technique in combination with phase cinematography is well established, it has not been considered wise to make detailed explorations on the effect of histamine, antihistamines, antigens, and immune bodies until a considerable body of information on the biology of the human nasal mucosa has been accumulated. Accordingly, several thousand feet of 16 mm. film records have been prepared which illustrate membrane behavior, including pinocytosis (cell drinking), nuclear activity, and the mobility of the mitochondria. In the course of these observations, nuclei were seen to exhibit rotatory activity.

*Grateful acknowledgment is made to Dr. Patrick Moran for his cooperation in obtaining the specimen and to Dr. M. Tobioka for the stained preparations.



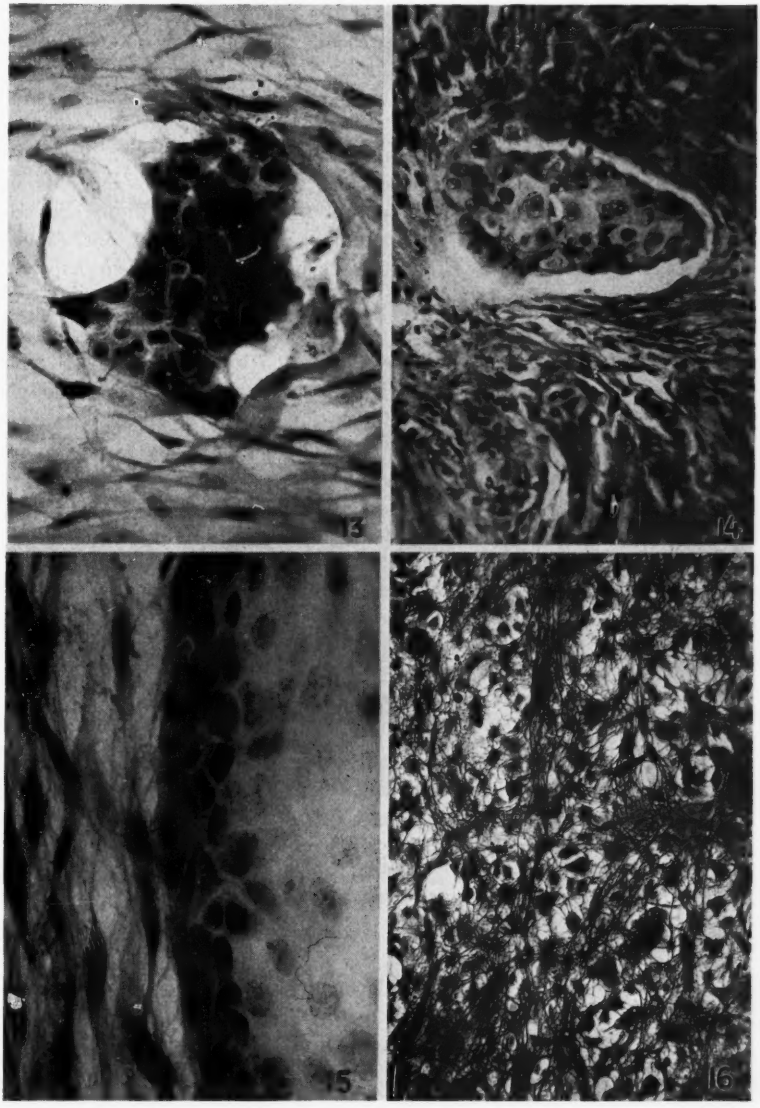






Figs. 9 and 10.—Cells from cultures of bronchial lining from a biopsy of the right lower lobe. The patient, a 72-year-old white man (WmBe—JSH 6639 I) with a diagnosis of intrinsic bronchial asthma and compensatory emphysema had a rectal resection for papillary adenocarcinoma two years earlier. Fig. 9, Outgrowth from a 4-day-old living hanging-drop culture showing a zone of emigrating epithelial cells. Ordinary light microscopy at low power. Fig. 10, A group of cells from the epithelial sheet shown in Fig. 9. Note the nucleoli (*N*), nuclear membrane (*M*), mitochondria (*Mt*) and fatty droplets (*F*). Oil immersion, dark phase contrast microscopy.

Figs. 11 and 12.—Mitochondria showing a diffuse pattern (Fig. 11) and perinuclear aggregation (Fig. 12) as revealed in a nine-day culture stained according to Polak's silver method.



Figs. 13, 14, and 15.—Photomicrographs from a study of a 62-year-old white man (W.A.Wh.—JSH 11315-F) with a moderate accumulation of pleural fluid. Jacobson's method used except in the section which was stained with hematoxylin and eosin. Figs. 13 and 14, A "lesion" consisting of an epithelial plate and surrounded with stromal elements as developed in vitro after twelve days of incubation, as compared with a characteristic growth found post mortem in the pericardium (Fig. 14). Fig. 15, Zone of contact between spindle elements and the epithelial plate in a 12-day-old culture. Careful examination revealed intercellular bridges which contributed to a diagnosis of squamous cell epithelioma probably of bronchial origin.

Fig. 16.—Meshwork of reticular fibers from a 31-day-old culture of cells in the chest fluid of a 53-year-old white man (PeHo—St.MI#5245-51) who showed an active pleural reaction. Rio-Hortega's double silver impregnation method.

In one sequence a nucleus was found which completed sixteen revolutions within seventy-five minutes, at one point the nucleus having turned through 360 degrees in seventy seconds.[15] Subsequently, nuclear rotation was observed in epithelia from other organs grown in vitro. Studies in progress are designed to clarify the mechanism involved and its meaning in the economy of the cell.

Current work also has demonstrated reactions in cell form and activity following experimental changes in electrolyte balance. Evidence is being accumulated which supports the view that 0.9 per cent sodium chloride in water is markedly nonphysiologic and that balanced salt solutions, especially those containing colloidal substances such as various plasma substitutes, might be used with far better results for washing delicate epithelial membranes.

Exfoliated Cells in Bronchial Secretions and Pleural Fluid.—Cell cultures are ideal for the study of free cells which are shed from various body surfaces. It was pointed out by Cone, Hooks, Pomerat, and Rose[16] that correlation studies might well be conducted between histopathologic, Papanicolaou, and tissue culture techniques in the analysis of the cytology of diseases affecting the urogenital tract. A broader statement of the problem was made by Pomerat, Nowinski, and Rose[17] and the application of the method to breast secretions was reported by Pomerat[18] and by McCormick, Jackson, and Pomerat.[19]

It would seem that the cultivation of cells in bronchial secretions and lavages from particular areas of the pulmonary tree might prove especially valuable for studies in chest pathology.

Several authors, notably Hengstmann,[20] Coman,[21] and Sano and Bello,[22] have given evidence of the value of tissue cultures of pleural fluid in the diagnosis of pulmonary disease. In our own series* several very interesting diagnostic enigmas have been unraveled. For example, the pleural fluid cultivated from a 62-year-old white man (W.A.Wh.-JSH 11315-F) produced a "lesion" on glass (Fig. 13) strikingly similar to that found post mortem (Fig. 14). A careful study of epithelial boundaries in the tissue culture revealed intercellular bridges (Fig. 15), an observation which lent weight to a final diagnosis of squamous cell epithelioma having probably originated from bronchial epithelium.

For in vitro studies, the rapid development of reticular fiber feltworks directly on the cover glass of cell cultures from pleural fluids lends itself favorably for experimental studies upon acellular fibrillar formation. Fig. 16 illustrates such a system in a 31-year-old culture of pleural sediment from a 53-year-old white man (PeHo—St.MI#5245-51) who showed an active pleural reaction.

It is hoped that a comprehensive analysis of an adequate series of the type provided by these illustrations may help in establishing a wider use of this very promising application of the tissue culture method in the study of chest diseases.

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*Work in progress in collaboration with Dr. E. J. Lefeber and Dr. G. G. Rose.

Grateful acknowledgment is made to Dr. A. P. Stout for his kindness in studying our preparations of tissue cultures.

SUMMARY

Methods are described for the study of pulmonary tissue and cells in pleural fluid with tissue culture technique.

Explants of human fetal tissues suggest attractive tools for the analysis of histogenesis and the development of congenital anomalies.

Surgical specimens and especially biopsies of the nasal mucosa and bronchial lining provide explants which become readily established in vitro and which invite challenging studies on the dynamics of cell activity. The analysis of nuclear rotation as seen in outgrowths from the nasal mucosa exemplifies newer knowledge emerging from the study of "living histology."

Data provided by the cultivation of cells from pleural fluid suggest the importance of adding such information to that obtained by well-established pathologic procedures as aids in understanding the nature of disease processes. It follows that the culture of cells from bronchial secretions may afford promising new diagnostic opportunities.

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CARCINOMA OF THE LUNG

A Report of 403 Cases

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Boston, Mass.

INTRODUCTION

THE increasing incidence of cancer of the lung has been amply documented in the recent literature. Thus, reviews by Graham,[1] Ochsner,[3] and others suggested that there has been an almost alarming increase in the number of diagnosed cases. This increase may be entirely absolute or partially relative. Inasmuch as carcinoma of the lung is the commonest cancer in males in many large institutions, it behooves all of us to examine our records and determine, if possible, what can be done to improve our results.

This report is based on a study of 403 patients with carcinoma of the lung seen at the Lahey Clinic during the past fifteen years. There were 350 males and 53 females, a ratio of 6.6 to 1, although, as will be indicated subsequently, this ratio does not hold for all types of bronchogenic carcinoma (Table I).

We were concerned especially in assessing our results in terms of five-year survivals; therefore, we divided the patients into those 159 seen before Jan. 1, 1948, and those 224 seen in the period from January, 1948, to December, 1952 (Table I).

Table I. Sex Distribution

Males	350
Females	53
Ratio—6.6 Males to 1 Female	
	Cases
Before 1948	159
1948 to 1952	244

Of great interest today is the question of cigarette smoking in relation to cancer of the lung. There is certainly some suggestive evidence of a causal relationship, but despite the enthusiastic endorsement of this etiological factor by eminent thoracic specialists, it would appear that a longer period of time will be required to settle this still controversial point (Table II).

Read at the Thirty-fourth Annual Meeting of The American Association for Thoracic Surgery at Montreal, Quebec, May 3 to 5, 1954.

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TABLE II. SMOKING (403 CASES)

	PATIENTS	PER CENT
Smoked	308	82.6 of 374 asked
Did not smoke	65	17.3 of 374 asked
Were not asked	30	

Thirty-eight of the 65 patients who did not smoke were women.
Five of 30 patients who were not asked were women.

DIAGNOSIS

Late diagnosis is the chief factor within our control accounting for poor end results. It is imperative that we should stress at every opportunity the importance of: (1) frequent and repeated roentgenologic surveys of the chest; (2) the follow-up of every abnormal shadow found; and (3) the follow-up of every thoracic symptom until it is explained. It is only in this way that operability will be increased and more cures result. We have seen cases of bronchogenic carcinoma which have been confused with almost every type of intrathoracic and constitutional disease, notably unresolved pneumonia, virus pneumonia, tuberculosis, influenza, asthma, angina pectoris, diaphragmatic hernia, and so forth. As will be indicated, the symptomatology associated with cancer of the lung is pathetically nonspecific, and the common symptoms of cough and chest pain are found in a number of intrathoracic diseases, many of which are innocent.

It is of interest, however, to note that there has been a slight statistical improvement in the group since 1948 with regard to the duration of treatment before reference to the thoracic specialist (Table III). Thus, in considering the former group, about 60 per cent were sent for treatment within six months of the time treatment was begun by the local physician, whereas in the more recent group almost 75 per cent were sent by their local physicians for special treatment within six months.

TABLE III. DURATION OF TREATMENT BEFORE COMING TO CLINIC (321 PATIENTS)

	PATIENTS
Before 1948	117
1948 to 1952	204
Treated six months or less	220
Before 1948	71 (61% of 117)
1948 to 1952	149 (73% of 204)

CLINICAL PICTURE

The symptoms of cancer of the lung in 403 patients are listed in Table IV.

It is to be emphasized that, although cough was present in a high percentage, it was by no means constant. Furthermore, the widely publicized symptom of hemoptysis was present in less than one-half of the cases, and it was the chief symptom in less than one out of five. The high incidence of weight loss and chest pain suggests the advanced state of the disease in many cases. This high percentage of inoperability is even more readily understandable when we consider that over 25 per cent of the patients reported here had their chief symptoms for more than one year (Tables V and VI).

TABLE IV. SYMPTOMS (403 CASES)

SYMPTOMS		PATIENTS	PER CENT
Cough		333	82.6
Productive	283		
Nonproductive	50		
Weight loss		276	68.4
Chest pain		231	57.3
Dyspnea		201	49.8
Hemoptysis		190	47.1
Weakness, fatigue		170	42.1
Wheeze		65	16.1
Other		280	69.4

TABLE V. CHIEF SYMPTOM (403 CASES)

SYMPTOM		PATIENTS	PER CENT
Cough		167	41.4
Productive	145		
Nonproductive	22		
Chest pain		142	35.2
Hemoptysis		72	17.8
Weight loss		57	14.1
Dyspnea		51	12.6
Wheeze		5	1.2
Other		115	28.5

TABLE VI. DURATION OF CHIEF SYMPTOMS BEFORE COMING TO CLINIC

DURATION (MONTHS)	PATIENTS	PER CENT
0 to 3	206	51
3 to 6	158	39
6 to 9	116	29
9 to 12	23	6
Over 12	112	28

On completion of the history and physical examination, the diagnosis of cancer of the lung was made in 260 cases, or 64.5 per cent of the total. Furthermore, metastases were indicated clinically in 105, or 26 per cent. The location of these metastases is included in Table VII. It will be noted that clubbing of the fingers was found in only 7 per cent of the cases and paralysis of the recurrent laryngeal nerve in 4.7 per cent.

TABLE VII. PHYSICAL EXAMINATION (403 CASES)

Tumor of lung diagnosed—260 cases or 64.5%	
Metastases—105 cases* or 26.0%	
Cervical	26
Bone	26
Axillary	10
Pleura	13
Liver	11
Spinal cord	10
Brain	4
Chest wall	3
Mediastinum	5
Pancreas	1
Involvement of recurrent nerve—19 cases or 4.7%	
Clubbing—29 cases or 7.1%	

*Two patients had metastases in two sites.

SPECIAL STUDIES

Roentgen Studies.—The roentgenogram is the most consistently accurate diagnostic tool at our disposal. The diagnosis was indicated by the radiologist in 364 of the 403 cases, or about 90 per cent (Table VIII). Many of these cases, however, were far advanced. New techniques in roentgen diagnosis are urgently required to permit earlier diagnosis of intrabronchial lesions. The use of high-voltage radiography is an encouraging step in this direction.

TABLE VIII. RESULTS OF DIAGNOSTIC PROCEDURES

	PATIENTS	PER CENT
Bronchoscopy	312	77.4 of 403 patients
Clinically positive	193	61.8 of 312 patients
Biopsy	184	
Positive	132	42.3 of 312 patients
Papanicolaou smear	117	
Positive	59	50.4 of 117 patients
X-ray positive	364	90.3 of 403 patients

Bronchoscopy and Cytology.—Bronchoscopy does not give the high percentages of positive results indicated by the earlier observers. In our hands, a positive diagnosis was made by this method in 42.3 per cent of patients who were submitted to the examination (Table VIII). There was one instance of false positive smear in the entire series, but cytological study was positive in 50 per cent of the proved cases in which it was employed.

TABLE IX. LOCATION (403 CASES)

	CASES	PER CENT
Left		
Upper lobe	61	15
Lower lobe	35	8.7
Main stem bronchi	13	3.2
Both lobes	2	0.5
Hilum	51	12.6
Total	162	40
Right		
Upper lobe	92	23
Middle lobe	11	3
Lower lobe	40	10
Main stem bronchi	18	4.5
Middle and lower lobes	8	2
Upper and middle lobes	2	0.5
Hilum	50	12
Total	221	55
Carina	7	2
Undetermined	13	3

Thoracotomy.—There were 217 patients, or 53.8 per cent of the total, subjected to exploration and thus given a chance for surgical relief. This will be discussed later.

PATHOLOGY

The gross pathology of primary carcinoma of the lung is epitomized in the diagram (Fig. 1). Unfortunately, the pathologic entities shown on the

right side of the drawing are still frequently encountered. The huge cancerous deposits around the carina, often with a relatively small, bronchogenic, primary lesion, are doubtless tumors once called sarcoma of the mediastinum.

Of the patients considered here, 221 had carcinoma of the right lung and 162 of the left, while 7 so involved the carina and lower trachea that the exact origin was in doubt (Table IX).

The microscopic pathology has been reported to us by Dr. Shields Warren and Dr. William A. Meissner of the New England Deaconess Hospital, Department of Pathology, as follows: (1) epidermoid carcinoma, 136 cases, (2) undifferentiated carcinoma, 90 cases, (3) adenocarcinoma, 43 cases, (4) carcinoma simplex, 30 cases, and (5) alveolar carcinoma, 2 cases (Table X).

TABLE X. PATHOLOGY (403 CASES)

	CASES
Epidermoid carcinoma	136
Undifferentiated carcinoma	90
Adenocarcinoma	43
Carcinoma simplex	30
Alveolar carcinoma	2
Total	301
Positive Papanicolaou smear only	27
Total positive diagnoses	328
No pathology	75
	403

Epidermoid Carcinoma.—This is the typical carcinoma of the bronchus in the male, and is often associated with atelectasis, necrotic cavitation, or abscess. It develops in the cuboidal or columnar normal epithelium of the endobronchus by a process of metaplasia and neoplasia. Thus, it is the lesion that could be the result of chronic bronchial irritation, such as might be caused by tobacco.

Undifferentiated Carcinoma.—As the name suggests, this neoplasm is so immature that it is not possible to determine the cell type of origin. This is variously described as anaplastic carcinoma, reserve-cell carcinoma, and oat-cell carcinoma.

Adenocarcinoma.—This is the lesion usually called adenocarcinoma Grade 2 by those who use Broders' scale. Of 43 patients in whom this diagnosis was returned, 13 (approximately 1 out of 3) were women. It will be recalled that for the total series of carcinoma of the lung, the ratio of females to males was 1 to 6.6. Furthermore, 13 of the 43 stated that they did not smoke, and 3 others probably did not.

The etiology of this type of carcinoma may be entirely different from that of the more common epidermoid cancer. Pre-existing congenital rests and benign tumors at times have been suggested. Here again, however, the evidence is far from conclusive. On this confession of ignorance, our present conception of the pathogenesis of carcinoma of the lung must temporarily rest.

Carcinoma Simplex.—This is the lesion that at times is called adenocarcinoma Grade 3 or 4. Occasionally, islands of very poorly formed glands may be found, but the majority of the tumor is composed of solid sheets of undifferentiated cells.

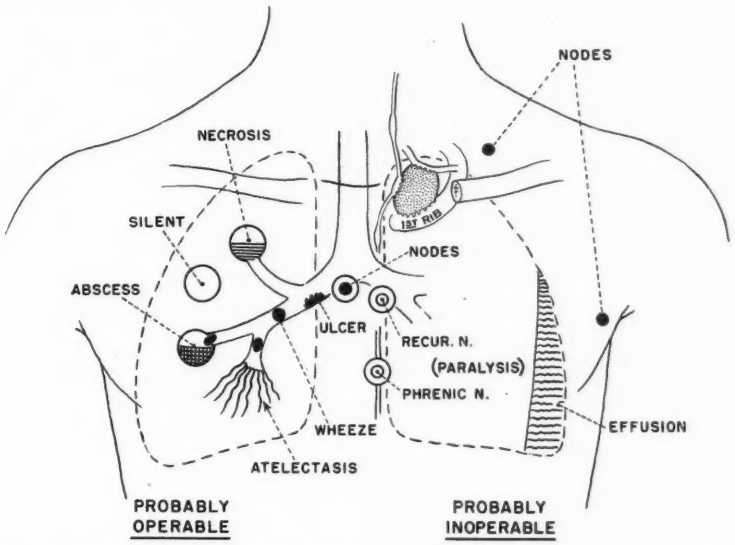

Fig. 1.—The gross pathology of carcinoma of the lung is shown diagrammatically. The erosion of the rib should be posterior. The liver should be carefully palpated and the pleural effusion searched for tumor cells.

Alveolar-Cell Carcinoma.—This is a rare lesion about which there has been considerable speculation in recent years. It has been compared to a South African sheep disease and, from the standpoint of pathogenesis, it is believed to have a multicentric origin. It may well be simply a variant of one of the other types. There were two recognized examples of this lesion in 403 cases.

TREATMENT

The Question of Lobectomy.—Despite the strongly expressed sentiments in the literature regarding lobectomy and realization of its inadequacy, there still will be many cases in a large experience in which lobectomy is mandatory (Table XI). Thus, a close inspection of the other lung may reveal roentgenologic changes suggestive of silicosis, fibrosis of other kinds, cystic disease, old inflammation, or emphysema. A low total pulmonary function or poor selective function on the contralateral side may indicate clearly the serious hazard of pneumonectomy. Although details of technique (Figs. 2 to 5) cannot be entered into here, it is to be emphasized that a very radical lobectomy may be done at times. This is especially so if the upper lobe is involved, as it is most frequently. Thus, with the pericardium opened and provisional control

of the main pulmonary artery established, the upper lobe artery may actually be cut away from the trunk artery and the defect carefully oversewn with two layers of silk. The first layer is a mattress of fine interrupted silk, after

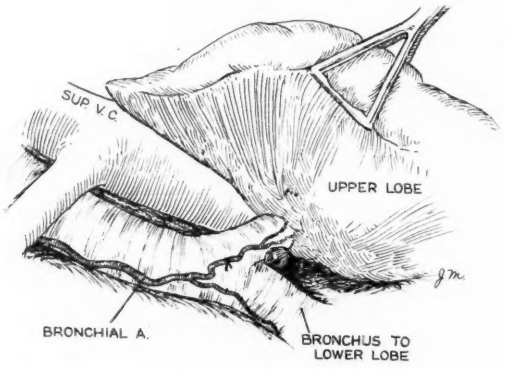

Fig. 2.—This and the succeeding three drawings illustrate the technique of radical lobectomy that is sometimes possible. The upper lobe is lifted forward and the azygos vein divided. The trachea and bronchi are wiped down, and the bronchial arteries ligated high. Lymph nodes at the lobar bifurcation may be included in the specimen. (From Surgical Practice of the Lahey Clinic, 1951, courtesy W. B. Saunders Company.)

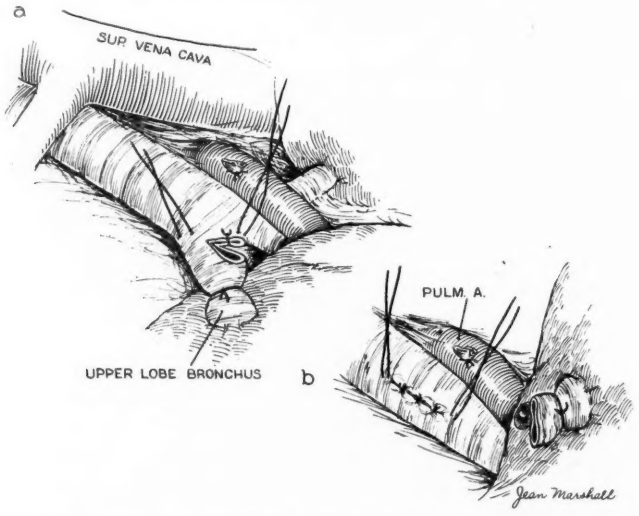

Fig. 3.—*a* and *b*, The lobe is then turned back, the lobar artery secured high and the bronchus amputated. (Courtesy W. B. Saunders Company.)

which the everted cuff is oversewn by a continuous suture of fine silk. This is very similar to our previously described manner of anastomosing the aorta after resection. Then the azygos vein may be divided and the trachea wiped clean down to and around the main bronchus.

TABLE XI. ANALYSIS OF 104 RESECTED CASES

	CASES	PER CENT
Total pneumonectomy	72	69.2
Right pneumonectomy	37	35.5
Left pneumonectomy	35	33.6
Lobectomy	32	30.7

Of 104 resected cases 32, or 30.7 per cent, were lobectomies. It will be seen later that several of these patients are included among the long-term survivals.

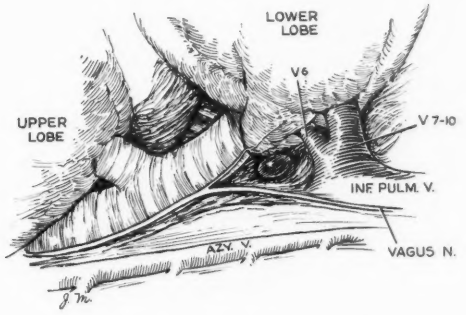

Fig. 4.—The hilar dissection is again begun posteriorly in a radical lower lobectomy. (Courtesy W. B. Saunders Company.)

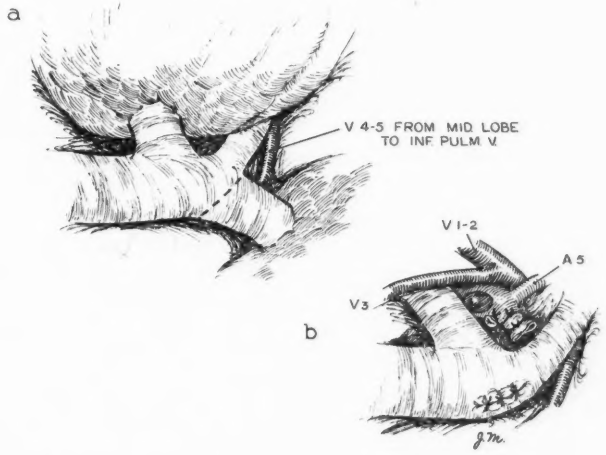

Fig. 5.—The arterial stumps and the treatment of the lower lobe bronchus are shown. (Courtesy W. B. Saunders Company.)

Combined Pneumonectomy and High-Voltage Therapy.—The ideal treatment is radical pneumonectomy, as described recently by us[2] and by others. Since the availability of two million volt therapy at Massachusetts Institute of Technology, a number of cases have been seen in which radical

surgery has been combined with massive radiotherapy. A preliminary report on this new approach to therapy has been presented elsewhere. In brief, it consists of attempting to make inoperable lesions resectable by interposing surgery midway along the course of radiation therapy (Fig. 6). We have not

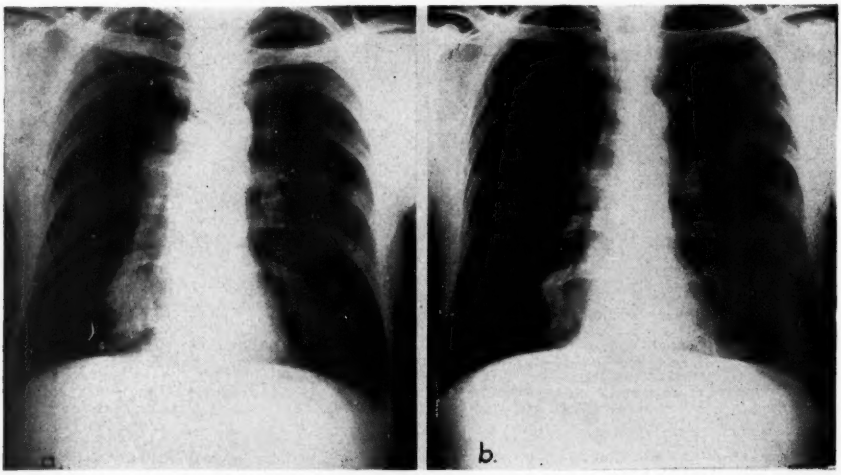

Fig. 6.—*a*, Large carcinoma of right lung found inoperable at bronchoscopy. *b*, After 3,500 r. of high-voltage therapy directed to the right hilum and superior mediastinum, improvement in the roentgenogram is apparent.

been impressed with our preliminary experience with this method, although it does make certain lesions resectable. Furthermore, we are persisting with the high-voltage therapy of certain squamous-cell carcinomas of the lung because we are sure they are sensitive to this type of therapy. In general, it can be said, however, that the x-ray is not a substitute for surgery because it destroys the lung and usually causes chronic abscesses and intractable cough. More recently we have given the total dosage of high-voltage therapy to these patients before operation. A total of 6,000 roentgens may be given without damaging the skin. In view of the destruction caused by this intensive therapy, pneumonectomy must be planned in addition. It has seemed wise to wait one or two months after cessation of therapy before operating on these patients. This permits the acute radiation reaction to subside.

Radical operation is accomplished with considerable difficulty in these cases. It is of great interest, however, to note that although neoplastic cells may be found in the specimen, they are necrotic and nonviable (Fig. 7).

Our experience with this entire aspect of therapy of carcinoma of the lung will be reported fully in the future.

Tables XII to XX give a résumé of our experience with high-voltage therapy in a total of 97 patients. The condition of the patients and the effects of treatment are such that only 61 of 97 completed the course. It will be

observed that 76 per cent of those who completed therapy are now dead. This small series could be materially improved statistically if 3 unusual cases were included as good results (Table XV). We have chosen not to do so, however, since they were relatively long-term surgical cures. Thus they are exceptions to the usual inherently vicious nature of the disease.

Fig. 7.—Specimen removed at pneumonectomy after high-voltage therapy. Note that neoplastic cells are present, but are necrotic and nonviable. Several scores of fields were searched before these stainable cells were found.

Our over-all experience in the therapy of carcinoma of the lung in 403 cases is summarized in Table XXI. It will be seen that resection was performed in 104 of 403 cases, a percentage of 25.8, while medical treatment only was advised on clinical examination for 186 patients, or 46 per cent. Surgery was refused by 11 patients, or 2.7 per cent of the group. It is of special interest to us to note that surgery appeared contraindicated for medical reasons in only 4 patients, less than 1 per cent of the group.

Resectability.—The accepted criteria of inoperability in the past have been extension to or fixation of the carina, obvious distant metastases and pleural fluid positive for tumor cells. We have made a special point of searching diligently in all cases for enlarged lymph nodes in the neck and the axilla, and in a number of cases we have succeeded in finding removable nodes for biopsy and thereby established the hopeless nature of the disease. On the other hand, as indicated and as reported previously, we have managed in a few cases to shrink down epidermoid carcinomas of the lung, using high-voltage roentgen therapy so that the carina was no longer involved. Needless

TABLE XII. CASES CONSIDERED INOPERABLE AT EXPLORATION; TREATMENT WITH HIGH-VOLTAGE X-RAYS ONLY

CASE	MIT NO.	PROVED PATHOLOGY	TIME INTERVAL (MONTHS) FROM DIAGNOSIS TO TREATMENT	TREATMENT TO LAST FOLLOW-UP	DIAGNOSIS TO LAST FOLLOW-UP	COMMENT
1	50-001	No	0	5 D*	5 D	General metastatic disease
2	50-049	Yes	½	4 D	4½D	Diffuse lung metastases
3	50-060	Yes	½	9 D	9½D	Recurrence in both lungs
4	51-023	Yes	1	10 D	11 D	Hemorrhage
5	51-071	Yes	½	22½D	23 D	Spine; visceral metastases
6	51-087	Yes	0	2 D	2 D	
7	51-089	No	14½	16½D	31 D	
8	51-092	No	0	7 D	7 D	
9	51-095	No	0	8½D	8½D	
10	51-107	Yes	0	5 D	5 D	Died after lobectomy for abscess following x-ray
11	52-091	No	0	16½	16½	No evidence of disease
12	52-271	Yes	0	3 D	3 D	
13	52-293	No	0	9½D	9½D	Distant metastases
14	52-314	No	0	9	9	Alive; metastases to liver and intestine
15	53-274	Yes	0	2½D	2½D	Multiple metastases
16	53-157	Yes	½	8	8½	Coughing, occasional hemoptysis
17	53-013	Yes	1	12½D	13½D	Metastases
18	53-260	Yes	0	3 D	3 D	
19	53-335	Yes	½	2 D	2½D	Metastases to liver
20	53-241	Yes	0	5 D	5 D	Metastases to liver
21	53-283	Yes	½	5 D	5½D	
22	53-276	Yes	1½	4½	6	Pneumonectomy for necrotic lung following x-ray
	Average		0.9	7.8	8.7	
	Range		0-14½	2-22½	2-31	
		Proved pathologically:		15		
		Not proved:		7		

Of 22 patients: 18 dead (average survival after diagnosis—8.1 months); 4 alive (average survival after diagnosis—10.0 months).

*D = Dead.

TABLE XIII. CASES CONSIDERED INOPERABLE AT EXPLORATION; TREATMENT WITH HIGH-VOLTAGE X-RAYS ONLY (CARCINOMA PROVED PATHOLOGICALLY)

CASE	MIT. NO.	TIME INTERVAL (MONTHS) FROM DIAGNOSIS TO TREATMENT	TREATMENT TO LAST FOLLOW-UP	DIAGNOSIS TO LAST FOLLOW-UP	COMMENT
1	50-127	3½	3 D*	6½D	Metastases to brain
2	51-117	1½	15 D	16½D	
3	51-119	1½	12 D	13½D	Cardiac failure
4	51-135	1½	9 D	10½D	Cardiac failure
5	52-044	1	11½D	12½D	Metastases to thyroid, opposite lung
6	52-146	1	15 D	16 D	Hemoptysis; ruptured aorta(?)
7	52-156	½	16	16½	Alive but terminal
8	53-047	1½	6½D	8 D	Metastases to ilium
9	53-230	½	4½D	5 D	Metastases to brain; primary thyroid(?)
10	53-041	1	9½	10½	Alive with brain metastases
11	53-195	1½	7½D	9 D	Massive hemoptysis
12	53-327	1	4	5	Fair except for pneumonitis
	Average	1.3	9.4	10.8	
	Range	½-3½	3-16	5-16½	

Of 12 cases: 9 dead (average survival after diagnosis—10.8 months); 3 alive (average survival after diagnosis—10.6 months).

*D = Dead.

to say, this will be of no avail if distant metastases develop, as may occur, but we have found no residual tumor in the chest of a patient with advanced disease who died of a distant metastasis.

TABLE XIV. ALL CASES NOT RESECTED: TREATMENT WITH HIGH-VOLTAGE THERAPY ONLY

		CASES	AVERAGE SURVIVAL (MONTHS)
Not resected		34	9.4
Unexplorable	22		
Explored—inoperable	12		
Alive		7	10.3
Dead		27	9.2

TABLE XV. THREE SPECIAL CASES TREATED SURGICALLY; RECURRENCE FROM 3 TO 9 YEARS LATER TREATED WITH HIGH-VOLTAGE THERAPY. ALL 3 PROVED PATHOLOGICALLY

		TIME INTERVAL FROM			
CASE	MIT. NO.	OPERATION TO X-RAY TREATMENT	X-RAY TREATMENT TO LAST FOLLOW-UP	DIAGNOSIS TO LAST FOLLOW-UP	COMMENT
1	52-290	3 years	9½ months	3 years 9½ months	Metastasis to brain; terminal
2	52-252	6 years 11 months	17 months	8 years 4 months	Cough and fever; excision of necrotic lung (?)
3	50-116	9 years 11 months	33 months	12½ years	Persistent cough; no adenopathy

Of the total cases of carcinoma of the lung, 25.8 per cent of the patients were submitted to resection (Table XXII). The total resections were almost equally divided between right and left total pneumonectomy. The future should witness a larger percentage of resectable cases.

TABLE XVI. TREATMENT SURGERY (LOBECTOMY) PLUS HIGH-VOLTAGE THERAPY (CARCINOMA PROVED PATHOLOGICALLY)

		TIME INTERVAL (MONTHS) FROM				
CASE	MIT NO.	DIAGNOSIS TO OPERATION	OPERATION TO X-RAY TREATMENT	X-RAY TREATMENT TO LAST FOLLOW-UP	DIAGNOSIS TO LAST FOLLOW-UP	COMMENT
1	51-076	0	14	17 D*	31 D	Metastases to opposite lung
2	52-092	0	1½	13 D	14½D	Metastases to brain
3	52-129	0	½	2½D	3 D	
4	52-153	0	½	4 D	4½D	
5	52-224	0	1½	15½D	17 D	Metastases to brain
	Average	3.6	10.4	14		
	Range	½-14	2½-17	3-31		

All patients dead; average survival 14 months.
*D = Dead.

MORBIDITY AND MORTALITY

Postoperative complications have been largely in the pneumonectomy group. In Table XXIII, it will be noted that there were 17 deaths in the entire group. Eight patients died in hospital following pneumonectomy, a

TABLE XVII. TREATMENT SURGERY (PNEUMONECTOMY) PLUS HIGH-VOLTAGE THERAPY (CARCINOMA PROVED PATHOLOGICALLY)

			TIME INTERVAL (MONTHS) FROM			
CASE	MIT NO.	DIAGNOSIS	OPERATION TO X-RAY TREATMENT	X-RAY TREATMENT TO LAST FOLLOW-UP	DIAGNOSIS TO LAST FOLLOW-UP	COMMENT
1	51-039	0	2½	24 D*	26½D	
2	51-070	0	½	12 D	12½D	Metastases to adrenals, kidney; no residual tumor in lung
3	51-161	½	1½	17	19	
4	52-089	2	—	9 D	11 D	Metastases to brain; operation midway through x-ray treatment
5	52-186	1	—	6 D	7 D	Operation midway through x-ray treatment
6	53-277	0	1	3	4	Feels well
7	53-163	0	½	3½	4	Feels weak
8	53-246	0	1	6	7	Metastases to bones
9	53-213	0	1	1½	2½	No follow-up
10	53-228	0	1	4½D	5½D	Carcinomatosis
11	53-217	0	½	8	8½	Alive but terminal
	Average			8.6	9.7	
	Range			1½-24	2½-26	

Of 11 cases: 5 dead (average survival 12.5 months); 6 alive (average survival 7.5 months).

*D = Dead.

TABLE XVIII. TREATMENT SURGERY AND HIGH-VOLTAGE THERAPY (ALL CASES)

		CASES	AVERAGE SURVIVAL (MONTHS)
Total		16	
Lobectomy	5		
Pneumonectomy	11		
Alive		6	7.5
Dead		10	13.2

TABLE XIX. TREATMENT WITH CONVENTIONAL X-RAY PLUS HIGH-VOLTAGE THERAPY

			TIME INTERVAL (MONTHS) FROM				
CASE	MIT NO.	PROVED PATH.	DIAGNOSIS TO CONVENTIONAL X-RAY	CONVENTIONAL TO HIGH-VOLTAGE X-RAY	HIGH-VOLTAGE TO LAST FOLLOW-UP	DIAGNOSIS TO LAST FOLLOW-UP	COMMENT
1	50-069	No	0	11	22 D*	33 D	Recurrence; pneumonitis
2	50-076	Yes	0	6½	30 D	36½D	
3	52-039	Yes	0	13	2½D	15½D	
4	52-094	Yes	0	½	9 D	9½D	Persistent disease
5	52-308	No	0	1½	6½D	8 D	Metastases to both lungs
6	50-143	Yes	0	1	5½D	6½D	Carcinomatosis
7	51-012	No	0	1	26	27	persistent cough
8	51-021	No	1	1	4 D	6 D	
	Average					17.8	
	Range					6½-36½	

Of 8 cases: 7 dead (average survival—16.4 months); 1 alive at 27 months.

*D = Dead.

TABLE XX. SUMMARY OF ALL PATIENTS TREATED WITH HIGH-VOLTAGE THERAPY (34), PLUS CONVENTIONAL THERAPY (8), OR PLUS SURGERY (19)

	CASES	PER CENT
Total (average survival, 11 months)	58*	
Began high-voltage therapy	97	
Completed high-voltage therapy	61†	63
Dead—April, 1954 (average survival, 11.2 months)	44	76
Diagnosis proved pathologically	50	82
Diagnoses in 50 Cases Proved Pathologically		
Epidermoid carcinoma		
Not graded	3	
Grade 1	2	
Grade 2	7	
Grade 3	6	
Adenocarcinoma	3	
Undifferentiated carcinoma	18	
Alveolar-cell carcinoma	1	
Papillary carcinoma	1	
Papillary adenocarcinoma	1	
Carcinoma, not classified	8	
Total	50	
Surgical Treatment in 61 Cases		
Inoperable	42	69
Explorable	31	51
Resectable	19	31

*Three unusual cases of recurrence 3 to 9 years after operation are excluded.
†Including 3 unusual cases (above).

TABLE XXI. SUMMARY OF TREATMENT—403 CASES

TREATMENT	NO.	PER CENT
Medical	186	46.1
Surgical		
Thoracotomy	104	25.8
Palliative	17	4.2
Curative resection	96	23.8
Total	403	

Total exploratory operations 217; 53.8 per cent of all patients were given chance for surgical relief.

TABLE XXII. RESECTABILITY (403 CASES)

	CASES	PER CENT
Resected	104	25.8 of 403 cases
Curative	96	23.8 of 403 cases
		or
		92.3 of 104 cases
Palliative	8	7.6 of 104 cases

mortality of 7.6 per cent. There was no mortality after lobectomy and there were 9 deaths after exploratory thoracotomy in which the lesion could not be removed, a mortality for thoracotomy alone of 8.6 per cent.

This is a reasonable mortality when it is considered that some of these cases were in the preantibiotic era and before selective pulmonary function studies were available. This mortality, like the resectability, should be subject to improvement in the future.

TABLE XXIII. MORTALITY

	DEATHS	
	NUMBER	PER CENT
Resected cases		
Pneumonectomy	8	7.6
Lobectomy	0	- -
Thoracotomy only	9	8.6
Total mortality	17	7.8 of those operated on

OVER-ALL SURVIVAL

The tragically low salvage in cases of cancer of the lung is well shown by the figures in Table XXIV. The average duration of survival of all patients is 10.7 months after discharge from the hospital or clinic. The average survival of all patients excluding those who lived five years is only 7.9 months. Those patients who were treated medically had an average life duration of only 4.2 months. Patients given x-ray therapy had an average duration of life after leaving the hospital of only 7.9 months.

TABLE XXIV. OVER-ALL SURVIVAL

	AVERAGE DURATION OF SURVIVAL (MONTHS)
All patients	10.7
Excluding 5-year cures	7.9
Medical treatment only	4.2
X-ray treatment only	7.9
Exploration*	8.9
Exploration only	5.1
Exploration and x-ray	12.6
Resection	27.9
Pneumonectomy	23.3
Lobectomy	32.5

*Small group.

Patients who had an exploratory operation lived an average of 8.9 months. All those who had resections lived an average of 27.9 months after discharge.

The course of every patient who had a total pneumonectomy was followed. One patient who had a palliative right upper lobectomy in 1946 could not be traced, and the few patients seen briefly in consultation who had no surgical procedure at the clinic are not included.

We were able to establish that 15 patients lived five years or more (Table XXV). This percentage is perhaps slightly higher than the usually reported salvage. It is 9.4 per cent of our total cases. To our surprise, one patient who had x-ray therapy only is alive after five years. This patient had a thoracotomy and positive biopsy by us, and we are indebted to Dr. William Watson of New York for follow-up notes. The patient was seen recently, but found to be failing in health from metastasis.

Of the other 14 patients, one died of recurrence at five years and one month. Two patients who are alive are believed to have a recurrence, one at

TABLE XXV. FIVE-YEAR SURVIVAL

		SURVIVED 5 YEARS OR MORE	
		NUMBER	PER CENT
Of all patients seen		15	9.4
Resection	14		
X-ray only	1		
After resection (palliative resections excluded)			32.5
After curative resection			37.8

five and one-half years, and one at eleven years. Eleven patients are living and apparently free from disease: 3 patients have survived five years, 3 six years, 2 nine years, 1 ten years, 1 eleven years, and 1 twelve years (Table XXVI).

TABLE XXVI. ANALYSIS OF 15 SURVIVORS

		CASES
Dead of disease in fifth year		2
Believed to have recurrence		2
At 5 years	1	
At 11 years	1	
Still alive		11
5 years	3	
6 years	3	
9 years	2	
10 years	1	
11 years	1	
12 years	1	

It is of interest to consider the pathology in the patients who lived five years, inasmuch as the majority of reported five-year cures in the literature are patients who had epidermoid carcinoma (Table XXVII).

TABLE XXVII. PATHOLOGY OF 15 PATIENTS LIVING FIVE YEARS

	CASES
Epidermoid carcinoma	
Grade 3	6
Grade 2	1
Grade 1	1
Adenocarcinoma	3
Undifferentiated carcinoma	2
Carcinoma simplex	1
Not stated	1

SUMMARY AND CONCLUSIONS

This statistical review of 403 carefully followed cases of carcinoma of the lung reveals the following: (1) The present-day therapy of carcinoma of the lung, while leaving much to be desired, yet clearly establishes the sound surgical basis for pulmonary resection. Thus, 9.5 per cent of all cases and 37.8 per cent of those given a curative resection survived five years or longer, with a total resection mortality for all the years of 7.6 per cent. (2) The

emphasis must be placed increasingly on patient and practitioner awareness. Only in this way can the long interval between onset of symptoms and resection be shortened. (3) Further research is indicated before we can state with any assurance the etiological factors involved in the various types of cancer of the lung. (4) High-voltage radiotherapy may have something to offer as an adjunct to surgery in the treatment of bronchogenic carcinoma. (5) Those who have the opportunity should persistently strive to bring about more chest surveys with complete follow-through and careful attention to all intrathoracic symptoms until they are fully explained.

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DISCUSSION

DR. JOHN H. GIBBON, Jr., Philadelphia, Pa.—I am always impressed with the similarity of the results obtained in different series; Dr. Boyd's results are quite similar to ours over the past seven years. We have seen that up to Jan. 1, 1954, there were 635 consecutive histologically proved carcinomas of the lung at the Jefferson Medical College Hospital in a period of seven years. I do not think the survival figures are too bad. Although only 9 per cent of all patients we have seen are alive five years later, in the group of patients in whom the tumor was removed (39 per cent of our entire series), we have a 26 per cent five-year survival. This is very similar to the series of Ochsner and DeBakey, and I think compares quite favorably with the five-year survival rate of gastrectomy for carcinoma of the stomach. In the cases where the cancer was confined to the lung our results are similar to Dr. Boyd's, i.e., over 40 per cent five-year survivals. In other words, if we can operate before the cancer has spread beyond the lung, we have a respectable percentage of five-year survivals. I do not think we should be too pessimistic about these statistics. At the present time the results of operation are as good as, if not better than, the results of operation for carcinoma of the stomach.

DR. RICHARD H. OVERHOLT, Brookline, Mass.—The precipitous rise in the rate of carcinoma of the lung as a cause of death makes this subject before this Association particularly significant, I think. As Dr. Gibbon said, the results of Dr. Boyd and of others add up to about the same. It was interesting to us to find in reviewing our cases that of 60 patients operated on before 1951 who are living today, one-third had had a palliative resection. This encouraged us to extend exploration in all cases where there is not positive evidence of extension beyond the lung. I cannot quite agree, however, with Dr. Boyd's enthusiasm about x-ray therapy.

We have checked back over a ten-year period and find that patients to whom we have given x-ray therapy have not lived as long as the ones that did not have it. In patients who had no thoracotomy, all histologically proved cases, we find that the irradiated patients lived an average of ten months from the first symptom, whereas patients who had no treatment at all lived on an average of thirteen months. So, by attempts at palliation, we did not actually prolong life.

In patients in whom we did an exploratory operation only, followed by x-ray therapy, the average length of life was fourteen months and, in the untreated, thirteen months. In other words, in this group, those given irradiation were given but one month

more to live and possibly suffer. We are not at all encouraged by this experience; I am not sure it is kind to punish the patient by radiation sickness during his terminal few months of life.

In the last consecutive 100 cases, most of them done in 1953, we explored 71 per cent and resected a lobe or lung in 46 per cent. We have done palliative resections in 31 per cent and curative resections—in cases where we could find no evidence of tumor outside the lung—in 15 per cent.

Prior to 1950 we treated a group of 30 patients for silent lesions. There were only 8 treated within three months of the first x-ray in that series; 6 are living today. There were 22 patients treated for silent carcinoma, but exploration had been delayed for several months; there are only 5 patients of that group living. This emphasizes again the fact that our best hope is to support all the survey programs and explore all suspect cases promptly.

DR. JOHN C. JONES, Los Angeles, Calif.—I should like to say a few words regarding my experience with carcinoma of the lung over an eleven-year period from 1942 through 1952. During that time my associates, Dr. Robinson and Dr. Meyer, and I saw 619 private patients with proved carcinoma of the lung. Of those, we considered only 300, or 48 per cent, to be clinically operable.

Twenty-five of these either refused operation or went elsewhere, so that actually only 275, or 44 per cent of the diagnosed patients, were explored, and only 144, or 23 per cent, had resections.

We wanted to see what our five-year follow-up would be. Prior to 1948 there had been 286 cases diagnosed. Of the 286, there were 41.6 per cent operated on, and 60, or 21 per cent, had resections, which of course includes the so-called palliative resections. Our over-all salvage rate is lower than that presented here. Only 17 patients, or 5.9 per cent of those diagnosed, are either alive today or died of causes other than carcinoma. Only 11 patients, or 3.8 per cent of the 286 diagnosed, are still alive. It is interesting to note in this group that two patients died after the five-year survival period, one seven and the other nine years after resection, both dying of metastatic or recurrent carcinoma of the lung.

The thing that discourages me is that we continue year after year to see so many patients who are not operable. We seem to be doing more and more extensive resections on patients who have more and more carcinoma, and I do not believe we are seeing these patients any earlier now than we were five years ago. Our operative mortality rate among the patients resected over the eleven-year period was only 4.9 per cent; but with a salvage rate of only 3.9 per cent, it seems to me to be a discouraging picture.

DR. ALTON OCHSNER, New Orleans, La.—I wish this discussion could be heard by the Academy of General Practice as well as our group. We have some statistics regarding the time at which these cases are seen. Actually, there is a longer delay today between the onset of symptoms and definitive therapy than there was five years ago, and it is almost invariably due to the fact that these people are being treated for viral pneumonitis. Interestingly enough, it is longer in the private series than in the charity series. There is an average delay of about six months in the private series as compared with three months in the Charity Hospital series. In other words, a person who is not able to afford a private physician comes to the Charity Hospital and has the diagnosis made in about half the time.

Our results are not as good as Dr. Boyd presented. In a total series of 1,365 cases, 442 were resected with a 19 per cent mortality rate. We feel that palliative resections are justified. We define palliative resection as a resection in the case in which there is extension beyond the lung. That is a rather broad application, but, actually, if one accepts this definition it is at least definite. Three-fourths of our cases showed extension beyond the lung. The mortality rate varies, of course, according to the period seen. Ours is still high, 12 per

cent, much higher than has been previously reported. Of the hospital deaths, 45 per cent were cardiovascular; 30 per cent were respiratory; 8 per cent were due to hemorrhage. These are the statistics that I would like to refer to in particular. One sees our over-all five-year salvage rate; this includes everyone subjected to operation or not operated upon, and everyone dying regardless of the cause of death. When one recalls that at this age only 85 per cent of the population are alive at the end of five years, we have a five-year salvage rate of 15 per cent in the resected cases as contrasted with a group of cases in which no operation was done, in which only one of 500 patients is alive four years after therapy. That one patient received nothing but nitrogen mustard, and he is the only one in the nonresected group who has lived that long.

When one contrasts the so-called palliative and the so-called curative resections, one finds that in the group of palliative resections about 7 per cent are alive. These are patients that I think would have been turned down by most thoracic surgeons, and we are very proud of even such a small group. In this curative resection group, 34 per cent are alive five years after resection.

To recapitulate the whole series; there were 55 per cent that were operable and 32 per cent resected; 26 per cent survived resection, with a five-year survival rate in the entire group of 6.6 per cent. I will not mention my ideas about smoking as a cause, for most of you know what they are; I think when the final page is written you will find that smoking is the real cause.

DR. JOSEPH GORDON, Albuquerque, N. M.—Although I have moved from upstate New York to the Southwest, I have maintained my interest in this problem. I have been asking about the incidence of carcinoma in the Indian, and have found some surprising answers. I wrote to Dr. Graham asking him what he thought of it. He said we might go on and consider it as a problem that may be of real value for study.

This is what I have learned: On a Navajo Reservation at Fort Defiance there is a 100-bed general hospital. In the past three years an enthusiastic group of physicians have been looking for carcinoma in all organs. They have reported to me that in a review of all cases entering this hospital, they have yet to see carcinoma of the lung in these Indians although it has been found in their other organs. They also said that in reviewing a twelve-year study of hospital records they have not found any recorded cases of carcinoma of the lung. This obviously brought up the question of smoking by the American Indian, whom we often blame for establishing the habit. I learned that they smoke very little; the older people particularly. They make a package of tobacco like Bull Durham last for a week or more. Smoking, therefore, is not very common on the reservation. This would be in contrast, I am sure, to the off-reservation young people, who appear to be taking up the habit of smoking a great many cigarettes. I think that if the members of this Association were to interest themselves in this problem it might help us in a long-term study of the subject.

DR. ARTHUR H. AUFSES, New York, N. Y.—I would like to review some figures compiled from a fourteen-year survey at the Mt. Sinai Hospital in New York City. It runs from 1935 through 1948, and therefore includes the worst years of carcinoma of the lung surgery and excludes the best years, those since 1948. We ended it in 1948 because we wished to have a five-year follow-up. The Mt. Sinai Hospital is a general hospital, and therefore this is a picture of carcinoma of the lung as it occurs in the general population in New York City.

We saw 959 cases of carcinoma of the lung in this fourteen-year period. We reviewed them in relation to the duration of symptoms before operation, and we had 32 patients who had no symptoms. Their tumor was discovered either on survey or on fluoroscopy in a doctor's office. In that group we had 44 per cent resectable cases. There are five patients of the 32 who are alive and well and considered cured. If you

look at the duration of symptoms before operation you will see that there is little difference in resectability, whether the symptoms were present for less than one month or as long as three years.

In no patient with or without node involvement was radical mediastinal dissection performed. In the patients with node involvement there is a 6 per cent cure rate, and in those without involvement there is a 30 per cent cure rate. This of course is to be expected.

We did about one-third lobectomies; of 165 resections 53 were lobectomies. In the lobectomies 26 per cent are considered cured, and in the pneumonectomies only 17 per cent are considered cured. Of course lobectomies are done for small lesions, limited to one lobe, and without gross lymph node involvement at the time of operation.

DR. DAVID P. BOYD (closing).—I shall not try to reply to the discussants individually. They are all men of vast experience in this field, and I really feel that many of the points of apparent difference are differences of viewpoint, perhaps even differences of temperament. We certainly need Dr. Gibbon's optimism in this distressing field. If I impressed Dr. Overholt as being very optimistic about any form of radiation therapy, I did not mean to be particularly enthusiastic. It may be an unconscious reaction on my part from the last time I gave a similar talk a few weeks ago in a southern city. After the talk was finished one of the discussants called me a cynic—in the politest of tones of course—and I remembered a line in one of Shaw's plays in which one of the characters says, "The power of accurate observation is called cynicism by those who do not possess the faculty." If that is so, I am content to be a cynic.

A CLINICAL SURVEY OF ADENOMAS OF THE TRACHEA AND BRONCHUS IN A GENERAL HOSPITAL

LAMAR SOUTTER, M.D., RONALD C. SNIFFEN, M.D. (BY INVITATION), AND LAURENCE L. ROBBINS, M.D. (BY INVITATION)
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ALTHOUGH the existence of endobronchial tumors other than bronchogenic carcinomas has been recognized for many years, their rarity has delayed the accumulation of sufficient clinical data to characterize them with certainty. The application of the term *adenoma* to a variety of neoplasms unrelated in either cellular pattern or clinical behavior has made matters worse. It has led to similar treatment for dissimilar tumors and particularly to the employment of indiscriminate radical surgery for lesions of both low and high degrees of malignancy. At the present time most pathologists recognize the *carcinoid adenoma* and the *cylindroma* as separate entities on the basis of their cellular patterns. In reviewing our own experience, we have studied only those cases in which the histologic pattern fell definitely into one of these two groups. Other tumors such as basal cell carcinomas and mixed tumors (similar to mixed tumors of the parotid) have been excluded as being microscopically different. All of the lesions which contained tissue resembling bronchogenic carcinomas histologically were classified and treated as such.

In the presentation of these cases the cylindromas have been separated from the carcinoid adenomas because the two categories have nothing in common either pathologically or clinically. The entire hospital experience with these growths, regardless of treatment, is presented here in an effort to correlate the courses of the patients with the malignant potential of their tumors. Over the period of years, 1909 to 1954, there were 56 carcinoid adenomas and four cylindromas diagnosed at the Massachusetts General Hospital. The follow-up has been complete, a point of major importance in any study subject to statistical analysis.

PATHOLOGY

The original microscopic diagnoses of the tumors presented in this series were carefully scrutinized. When necessary, fresh slides from the original specimens were made. No tumor which had been identified originally as an adenoma was found to be a bronchogenic carcinoma, but at least five tumors which had been classified as "low-grade carcinomas" were reclassified as carcinoid adenomas on the basis of this study.

Carcinoid Adenoma.—Microscopically, all 56 of the carcinoid adenomas of this series fitted into the standard pattern for the disease. Basically, they were

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composed of small, polygonal epithelial cells of uniform dimensions with a finely granular acidophilic cytoplasm (Fig. 1). The nuclei were round or ovoid and contained a fine chromatin precipitate; visible nucleoli were uncommon. The cells were arranged in anastomosing columns of varying diameter or in small masses suggestive of acinar grouping. Uncommonly, true acini were formed without visible content or were filled with a nonmucinous, finely granular, protein precipitate. The cell columns and groups were intimately associated with many sinusoids presumably of both vascular and lymphatic origin. A delicate fibrous stroma enclosed the sinusoids.

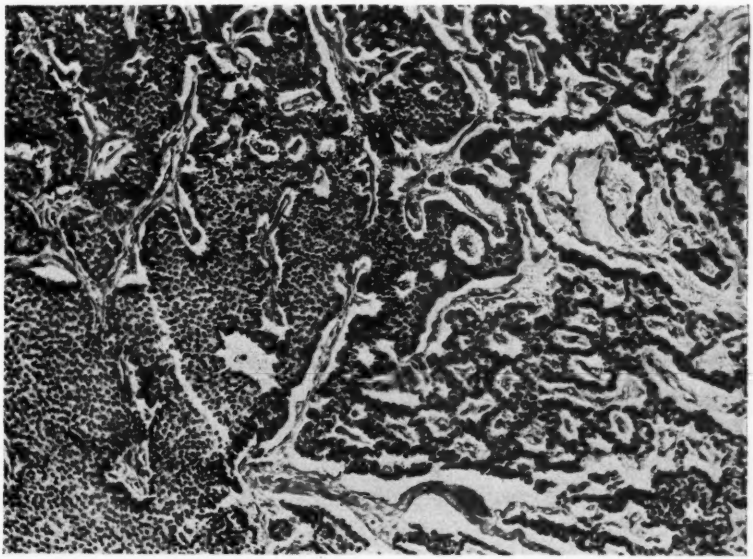

Fig. 1.—A typical carcinoid adenoma composed of anastomosing columns of uniform cells. The intimate association of the columns with numerous sinusoids is apparent.

Some variations were usually evident in the basic pattern. Some tumors contained nuclei that varied considerably in size and had occasional giant forms. The latter were reminiscent of the giant nuclei found in many parathyroid adenomas. Bone spicules could be found in some of the tumors apparently arising in an included bronchial cartilage or in the stroma itself.

Evidence of malignant activity was manifested by the following: First, mitoses, although distinctly rare, were found in six tumors. Second, there was microscopic evidence of penetration of the tumor through the capsule into adjacent lung in 25 of the 30 encapsulated tumors in which this could be studied. Third, secondary deposits of tumor in adjacent lymph nodes were found in three patients. In one patient there was a single metastasis in one out of sixteen lymph nodes submitted with a resected left lung; invasion of a lymphatic channel was found in this case. In another, two out of five lymph nodes were found to contain tumor in a specimen consisting of two lobes of the right

lung. In the third, whose autopsy followed death from pneumonia, a lymph node measuring 2 by 3 cm. was found to be replaced almost totally by tumor. This case was reported by Holley.[1] On microscopic examination the metastasis was similar morphologically to the tumor which had been removed from an adjacent bronchus by an endoscopist at intervals of two, four, and six years previously. At post-mortem examination no residual tumor was apparent in the bronchus. Although blood vessels were occasionally compressed by these adenomas, none were invaded, and there was not a single case of hematogenous spread.

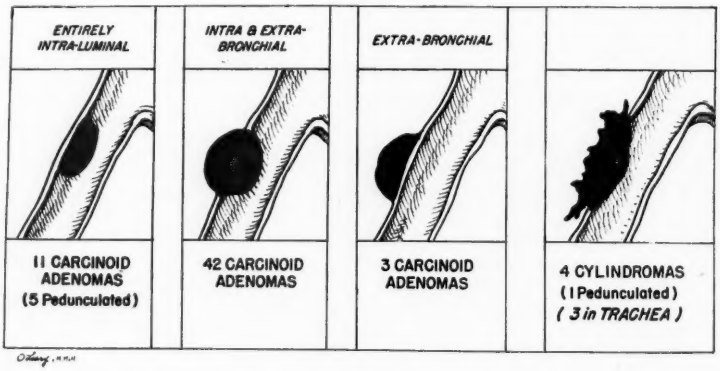

Fig. 2.—Schematic drawing showing relationship of carcinoid adenomas and four cylindromas to the wall of the bronchus and trachea.

Grossly, these tumors appeared to be well circumscribed and noninvasive. Their positions in relationship to the bronchial wall and lumen are shown in Fig. 2. The main tumor mass was either polypoid, sessile, intramural, or extramural. The most common mode of growth produced a small intrabronchial protrusion, and intramural invasion, with the bulk of the tumor lying outside of the bronchus. Only eleven of the tumors appeared to be entirely intrabronchial and superficial to the bronchial cartilages. Only five were actually pedunculated. Pedunculation was often deceptive because some neoplastic cells usually penetrated through the bronchial wall. In three cases, tumors arising at the bifurcation of a bronchus extended in fingerlike cylinders down both dilated bronchi, but remained intrabronchial. In no instance was the extrabronchial tumor mass greater than 4.5 cm. in diameter. Three tumors lay entirely outside of the cartilage plates.

Intermittent or complete obstruction of bronchi by these growths often caused considerable pulmonary suppuration with irreversible pathologic changes. In brief, as demonstrated either radiographically or by examination of tissue removed at operation or at autopsy, 33 patients had bronchiectasis, 20 had pneumonitis, 11 had empyema, 5 had lung abscesses, 2 had acute bronchitis, and 2 had pulmonary fibrosis. Only 7 out of 56 patient had no evidence of permanent pulmonary damage.

Cylindroid Tumors.—Cylindromas, found most commonly in the trachea, but also occurring in major bronchi, bear little resemblance to carcinoid tumors. Though similar on gross inspection, the invasive nature of the cylindroma is usually apparent. Like carcinoid adenomas, they may have a polypoid intraluminal mass with or without extension through the wall of the airway to form an extramural projection. When the tumor extends beyond the wall of the trachea or bronchus, no capsule developes and invasion of neighboring structures occurs.

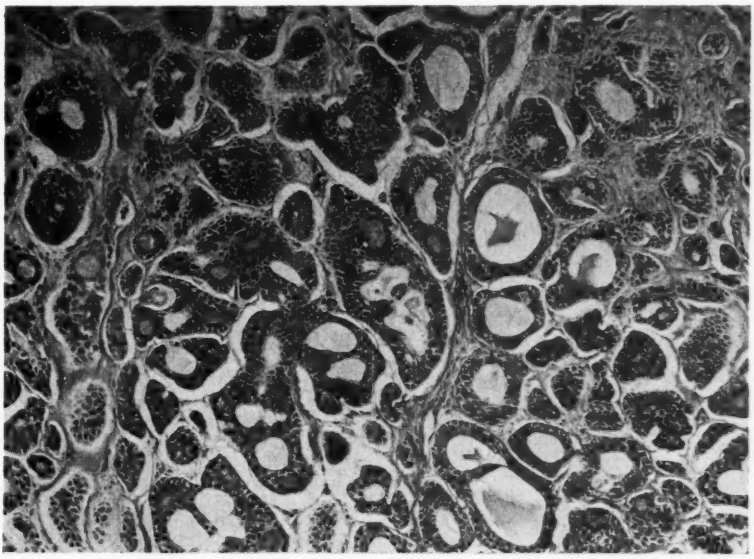

Fig. 3.—A cylindromatous tumor forming acini filled with mucinous material. The conformation is ofen reminiscent of mucous gland ducts.

The basic structure of the cylindroma is a series of branching tubules and acini embedded in relatively avascular connective tissue of varying density and abundance (Fig. 3). Frequently the acini contain mucinous material. The typical cell is small and uniformly basophilic. Mitoses are more common than in carcinoid adenomas.

In three patients in this series the cylindroma originated in the trachea. One was pedunculated, but invaded the wall of the trachea and no capsule had formed. The second invaded the wall of the trachea almost in its entirety, extending into the thyroid gland but producing no mucosal ulceration. The third tumor invaded the thyroid with fingerlike projections. In a fourth patient, the cylindroma originated in the right intermediate bronchus and had already spread to the lobar bronchi when a right pneumonectomy was performed. Over thirteen years later, after tumor recurrence and at autopsy, there was invasion of trachea, pericardium, and left auricle. Residual tumor

was found in the stump of the right main bronchus. The left main bronchus was encircled by the growth as was the esophagus and superior vena cava. The most interesting attributes of these cylindroid neoplasms were their benign appearance, cellular uniformity, paucity of mitoses, and remarkable ability to invade the perineural lymphatic channels.

SEX AND AGE

In this series 31 males and 25 females had carcinoid adenomas; their average age at the onset of symptoms was 33.1 years. Three patients dated the onset of their symptoms from the time when completely asymptomatic lesions were removed because abnormal routine chest roentgenograms had led them to seek medical advice.

The time of diagnosis for the 56 patients was established as follows: For four it was the time when a shadow was first observed roentgenographically which was later found to be consistent with carcinoid adenoma and was ultimately removed. For one, it was established by bronchoscopic observation and subsequently confirmed by resection. For the remainder it was the time when the diagnosis was first made on the basis of microscopic section.

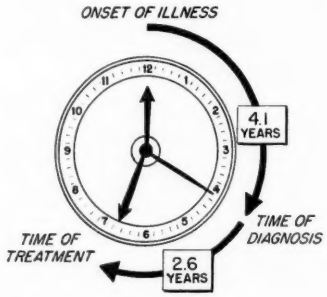

Fig. 4.—The average delay in years between onset of symptoms, time of diagonsis, and operation for 45 patients who underwent definitive surgery for carcinoid adenomas.

The average age at the time of diagnosis was 37.9 years; the youngest was a 10-year-old girl and the oldest a 76-year-old man. At the onset of symptoms the average age was 33.1 years. This is a difference of 4.8 years with a minimum of 0 and a maximum of 20 years. In considering only those 45 patients whose carcinoid adenomas were removed surgically, the average age at the onset of illness was 32.2 years; at the time of diagnosis it had risen to 36.3 years, but by the time of definitive surgery it was 38.9 years. The delay in years between those ages is shown graphically in Fig. 4.

Of the four patients who had cylindromas, two were males and two females. Their ages at the time of diagnosis were 35, 36, 63, and 65 years, respectively.

SYMPTOMS

Although no specific symptoms serve to identify endobronchial tumors, a prolonged history of pulmonary infection, cough, and hemoptysis in a young

adult may arouse the suspicion that an adenoma is present. As the disease develops over the years, the symptoms will change, particularly if pulmonary infection becomes chronic. In general the symptoms fall into three groups: those immediately referable to the presence of a tumor in an airway, those associated with infection of the lung, and, last, the reactions of the body as a whole to pulmonary suppuration and collapse. In the first group we find cough, hemoptysis, and wheeze; in the second, bouts of pleurisy, bronchitis, and pneumonia; in the third, chills, fever, malaise, weight loss, and dyspnea. The most prominent symptoms have been outlined in Table I.

TABLE I. 56 PATIENTS WITH CARCINOID ADENOMAS. FREQNUENCY OF MAJOR SYMPTOMS

COMPLAINT	FREQUENCY	AS INITIAL COMPLAINT	AS CHIEF COMPLAINT ON HOSPITAL ENTRY	NONE
Cough	52	21	19	4
Hemoptysis	39	13	15	17
Wheeze	4	0	1	52
Bouts of pneumonia	36	11	8	20
Bronchitis	4	0	0	52
Pleurisy	9	6	5	45
Dyspnea	4	0	1	52
Fever	9	2	4	—
None	3	—	—	—

It is noteworthy that cough, both hacking and productive, was a very common symptom. Blood-streaked sputum was reported by 28 patients, but massive bleeding (several ounces or more) by only 11. In one form or another, bleeding was complained of by 17 out of 18 patients whose symptoms were of ten years' duration or more. It is interesting to note that of the 28 patients who had bleeding, there were only three in whom no pathology other than the adenoma was demonstrable. The systemic symptoms were rarely the basis of chief complaints.

The three patients with tracheal cylindromas complained of dyspnea on inspiration; the one with a bronchial lesion complained of cough.

DIAGNOSIS

Roentgenographic.—Roentgenographic findings are of major importance in establishing the diagnosis of adenoma. Even routine or survey methods will usually indicate the presence of some abnormality. Because of the many years spanned by this series, the films of only 46 patients are still available. In nearly half of these it was possible to visualize a portion or all of the tumor (Fig. 5). In the remainder only those changes associated with bronchial obstruction were seen. The most commonly associated conditions are collapse, bronchiectasis, acute pneumonitis, or lung abscess. Collapse was demonstrable in 35 of the 46 cases and bronchiectasis with or without collpase in 26. Bronchiectasis was demonstrated more often on plain films than by bronchography. Air-containing, dilated bronchi could be readily distinguished from surrounding areas of inflammation or scarring when pneumonitis or collapse was present. Often in such instances the injection of opaque media into the bronchiec-

A. *B.* *C.*

Fig. 5.—*A* and *B*, Carcinoid adenoma in a bronchus. Note the collapsed right lower lobe lying posteriorly in the lower portion of the right chest. Within the superior portion of the area of density several small bubbles are noted which suggest the possibility of abscess. There is evidence of old rib resection. *C*, Lateral bronchogram reveals a mass in the right lower lobe bronchus just below the middle lobe orifice.

tatic areas could not be accomplished because of obstruction produced by the tumor. In only a few cases was the bronchial obstruction recognized in its early stage when obstructive emphysema was the primary finding.

A. *B.*

Fig. 6.—*A*, Cylindroma of left main bronchus. Opacity of the right chest as a result of pneumonectomy thirteen years before. Note the displacement and involvement of the esophagus. There appears to be some narrowing of the left main bronchus throughout its length. *B*, The involvement of the esophagus and wall of the left main bronchus is more clearly demonstrated.

In half of the cases the tumor mass was obscured by an inflammatory reaction in the adjacent lung; in the remainder, it was possible to identify the tumor. Its size, which could then be approximated, varied from a few millimeters to several centimeters in diameter. Usually the mass was of homogeneous density; ossification or calcification was demonstrable within the tumor in six cases; in no instance was central necrosis seen. The observable portion of the tumor was usually smooth in outline or slightly lobulated, round or ovoid in shape, and submucosal or extrabronchial extension was often clearly demonstrated. The intraluminal mass, as contrasted to that of an early carcinoma of one of the larger bronchi, appeared to be rounded like an intestinal polyp. The large extrabronchial extension of some carcinoid adenomas resembled primary or secondary tumors of other types.

The cylindromas were distinctive because of their irregular infiltrating appearance and their tendency to constrict long narrow segments of trachea

or bronchus (Fig. 6). There was no evidence of pathologic changes in the lung distal to the tracheal cylindromas; bronchiectasis was associated with a cylindroma which had arisen in the right intermediate bronchus.

When only films of high contrast were obtained, actual demonstration of a tumor mass which lay in the lumen of a major bronchus was often impossible. To outline the trachea and major bronchi clearly, a high kilovoltage technique was employed and at least one posteroanterior or anteroposterior projection using a grid or Bucky diaphragm was obtained. In addition, it was essential that the patient be fluoroscoped. Spot films were helpful and laminagraphic studies were occasionally of great importance. In a few instances it was necessary to resort to bronchography for actual demonstration of the tumor, but this latter method has been abandoned for the most part in favor of laminagraphy.

Bronchoscopic.—If a transthoracic excision of a tumor is planned, it is exceedingly helpful to the surgeon to have the roentgenographic findings and the history, suggestive of adenoma, confirmed by biopsy. Thirty-five of the carcinoid adenomas and both of the resected cylindromas were thus identified before resection. (A histologic diagnosis for every tumor was ultimately obtained by bronchoscopic biopsy in 46, at operation in 11, and at autopsy in 3.)

Radical surgery was avoided in three instances in which it would have been undesirable because preoperative bronchoscopic observation indicated that the tumors were carcinoid adenomas. Five other tumors resected thoracically were too peripheral to be seen at bronchoscopy.

The final decision as to the type and extent of treatment depends on the accuracy of diagnosis.

TREATMENT

Radiation Treatment.—Experience with radiation therapy of either the carcinoid or cylindromatous type of adenoma has been limited in this hospital. In all there were eight patients who received some form of radiation therapy at some time during the course of their disease. All of these were treated in or prior to 1938, before the present-day concepts of dosage determination were in effect. In consequence, the total doses delivered cannot be estimated with accuracy.

Three patients were treated by insertion of radon seeds into the tumor through the bronchoscope; the remainder received varying amounts of x-ray. (Only three of them were treated at this hospital.)

Extensive discussions of the use of radiation therapy in carcinoid adenoma of the bronchus have not been found. In most reports there is only an occasional case mentioned in which radiation therapy had been used. This lack of information plus the small number of patients treated in such a manner in this series, particularly in view of the lack of accurate dosage measurement, makes it impossible to evaluate radiation therapy. However, even though the tumor might respond to radiation treatment, the associated damage of the

distal lung or bronchi would receive no benefit. From theoretical considerations and limited experience, therefore, radiation therapy offers little permanent value, and surgical extirpation evolves as the treatment of choice.

In the treatment of cylindromas, which are most often located in the trachea, a trial course of radiation therapy with the hope of producing a good regression may be justified. Should this be unsuccessful, there would be sufficient opportunity for later surgical intervention. From the little information now available, it is assumed that reasonably large tumor doses might be necessary. Too little factual knowledge is at hand, however, to justify drawing any conclusions.

Operative Treatment.—Apparently complete operative resection of the tumor was carried out in two patients with cylindromas and in 45 with carcinoid adenomas. During the 1920's and early 1930's when thoracic surgery was hazardous and the malignant potential of the adenoma unconfirmed, bronchoscopic resection was the treatment of choice. Only one patient in this series, a man whose carcinoid adenoma was removed and the base implanted with radon seeds bronchoscopically in 1932, was both cured of the tumor and escaped distal lung damage. In three others the local removal of tumors was apparently complete, but subsequent lobectomies were necessary because of chronic pulmonary sepsis. Transthoracic procedures at first were limited to the drainage of empyemas or lung abscesses, but gradually lobectomy and pneumonectomy were introduced for the treatment of uncontrollable infection or hemorrhage. Following the first cure by lobectomy in 1931, the direct approach to the problem became increasingly popular. Bronchoscopic resection has been gradually relegated to the treatment of the bad-risk patient. Since 1945 only one patient, a man of 70 who was a very poor risk for any other type of surgery, has been so treated.

The extent of the resection must be determined in each instance at the time of operation. In this series, the rounded, noninvasive nature of the carcinoid adenoma and the lack of obvious metastasis (in all but two cases) were deciding factors. In both of the patients with lymph node involvement, the condition was recognized when the chest was opened and adequate resections were therefore performed.

All of the carcinoid adenomas in this series have been technically operable; two of the four cylindromas, because of the extent of the tracheal involvement, were not. Of the two removed, one was by a partial tracheal resection and the other by a right pneumonectomy.

Fig. 7 depicts the operative procedures schematically. In the carcinoid group there were 27 tumors in the left bronchial tree and 29 in the right; but 13 pneumonectomies were performed on the left and only two on the right. The length of the left main bronchus was partially responsible for this discrepancy, but, in addition, a tumor at, or close to, the bifurcation of the left upper and lower lobes usually required removal of both lobes. A similar situation was found in tumors at the right middle and lower lobe bifurcation which necessitated bilobectomy. Tumors arising in the right intermediate

bronchus were treated similarly. There were 11 of these bilobectomies. When they are added to the right pneumonectomies, the total equals the number of left pneumonectomies. It is interesting to see how frequently permanent changes in lung tissue associated with the tumors necessitated resection of lung tissue. Complete or partial destruction of two lobes from previous infectious processes led to seven pneumonectomies and nine bilobectomies.

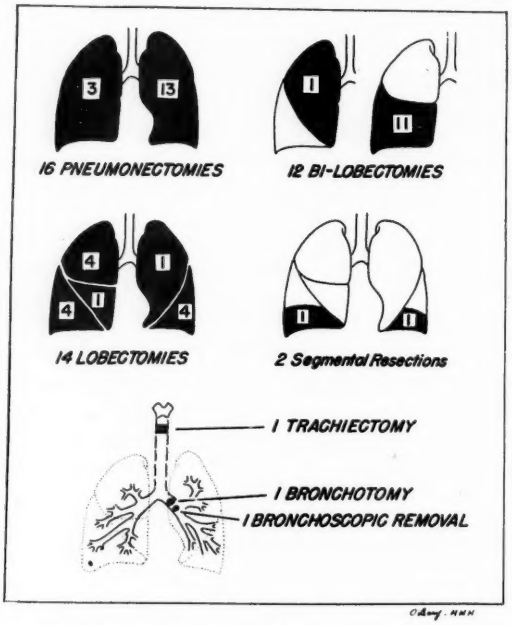

Fig. 7.—Schematic drawing showing the areas of resection for two cylindromas (one by trachectomy and one by right pneumonectomy) and for 45 carcinoid adenomas.

Technical difficulties caused by the size of the tumor or its proximity to the interlobar bifurcation prevented preservation of a normal lobe in all of the remaining cases; in only one case, that of a right pneumonectomy, was there normal lung tissue in all of the lobes. The long delays from the onset of symptoms to the time of extirpative surgery were probably directly responsible for the necessity of sacrificing so much tissue in so many instances.

Interestingly enough, two of the pneumonectomies were staged. Both patients were first treated by left lower lobectomies (using the tourniquet technique) because of severe pulmonary suppuration. The tumors were not included in the specimens. A year later (1936) the remaining lobe and the adenoma were resected for one patient because of continued infection. The growth was in the main bronchus and the man died postoperatively. Fifteen years later the remaining lobe and tumor were removed from the other patient because of hemoptysis. The tumor was in the stump of the lower lobe bronchus; this patient is alive and free of disease at present. Neither had metastases.

In one instance when the adenoma lay partially in both the upper and middle lobes and the fissure between was incomplete, excision of both lobes was carried out. Single lobectomies were performed in 14 instances, in only two of which did technical reasons demand removal of so much tissue; in the others it was because of irreversible pathologic changes in the lung. Recently, because patients have been referred much earlier in the course of their illnesses, it has been possible to treat two patients by resecting the basal segments of a lower lobe and one by a partial resection of the left main bronchus. None had detectable lymph node metastases nor any permanent damage in their lung tissue.

The postoperative course of these patients expressed in both complications and operative mortality reflects the progress of thoracic surgery. The first resection, a right lower and middle lobectomy was performed by Dr. Edward D. Churchill in 1931. The patient recovered and is living and well over twenty-two years later. During the 1930's sepsis was a considerable problem. The only two operative deaths, both after lobectomies and both from sepsis, occurred during this era, the last in 1936. Complications diminished rapidly after the advent of the antibiotics and since 1945 have been of only minor consequence. In our whole group 45 transthoracic resections have been carried out with an operative mortality of two cases, or 4.5 per cent.

RESULTS

No study of the effects of tumors upon their human hosts can be of value unless the basic histology of the growths consistently follows a pattern acceptable to pathologists, and the follow-up of the patients is both long and absolutely complete. The addition of tumors of dubious or unrelated histology and the loss of a single case to follow-up can invalidate the statistical conclusions of a small series. We are presenting, therefore, a follow-up on all patients who have entered the hospital between 1908 and 1954 with carcinoid and cylindroid tumors. The results have been analyzed for the group as a whole—for those who have died, for the untreated patients, and for those who underwent definitive surgery.

Out of 56 patients who had carcinoid adenomas, 41 are living. For 45 patients the diagnosis was made long enough ago (before 1949) that they could have lived for at least five years subsequently. Thirty-three, or 73.3 per cent, have survived five or more years irrespective of whether or not they received any therapy. Of the four patients with cylindroid tumors, three were diagnosed long enough ago to permit a five-year survival; all of them lived at least that long irrespective of treatment; two are now alive. In surveying the cases of microscopically proved bronchogenic carcinoma, regardless of whether the patients received therapy or not, we found that in a comparable period of time only 15 out of 366, or 4.1 per cent, survived five years or more. In Fig. 8 the survival rates for bronchogenic carcinoma and carcinoid adenoma are presented.

Pehaps the most reliable means of determining whether the malignant implications of the cytological pattern of a tumor are warranted is by studying the causes of death for the patients who have been afflicted with the dis-

ease (Table II); fifteen patients in this series who had carcinoid adenomas have died, ten were autopsied. The causes of death in the five who were not examined post mortem are as follows: One patient, whose tumor was not resected, died of pneumonia at the age of 72. Another, a young woman of 32, died at home of hemorrhage a few days after a bronchial biopsy. Three others died at four, four, and seven years, respectively, after lobectomies: none of the three had had recognizable lymph node involvement at operation. The causes of death among them were cerebral hemorrhage in a man of 66, arteriosclerotic gangrene of the leg and diabetes in a man of 81, and cardiac failure secondary to arteriosclerotic heart disease in a man of 61. These patients had been followed in our clinic as well as being cared for by their own doctors. No clinical evidence of metastases was ever established, but the presence of residual disease cannot be completely excluded.

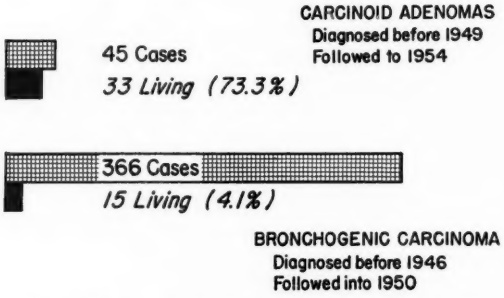

Fig. 8.—Comparative five-year survival rates for patients with bronchogenic carcinoma and carcinoid adenoma. All cases treated and untreated are included. None of the deaths in the adenoma group came from the tumors themselves.

Of the ten patients upon whom autopsies were performed (Table II) only one showed any evidence of metastatic disease. This man, whose tumor had been removed locally by bronchoscopy two years previously and who had also received a short course of roentgen therapy, died of pneumonia. At postmortem examination six years after the diagnosis had been established, there was no microscopic evidence of residual bronchial disease, but there was a single metastasis in an adjacent lymph node. Four patients who had been treated by pulmonary resection were autopsied; two had died postoperatively. Another died of an adrenal carcinoma two years after resection of the lung and three years after the establishment of pulmonary diagnosis. The fourth died of a scirrhous carcinoma of the stomach two years after lobectomy.

The cylindromas, by contrast, although slower in development and less lethal immediately than bronchogenic carcinomas, were far more malignant in behavior than the carcinoid adenomas. Two patients with cylindromas died and were autopsied. In one, death was due to asphyxia, despite the insertion of a metal airway to relieve the obstruction caused by tumor which had extended the length of the trachea and had invaded surrounding structures. The other, who had had a pneumonectomy over thirteen years previ-

ously for a tumor arising in the right intermediate bronchus, remained asymptomatic postoperatively until a few months prior to re-entry. He was then re-explored with the hope of resecting a local recurrence which had partially occluded his left main bronchus. Widespread local metastases rendered extirpation of the tumor impossible. At autopsy a few days later evidence of extensive recurrence in the mediastinum was confirmed. No distant metastases were found in this patient or in the other one.

TABLE II. CAUSE OF DEATH IN 15 PATIENTS WITH CARCINOID ADENOMAS, 2 WITH CYLINDROMAS

YEAR	AGE	YEARS OF SURVIVAL		AUTOPSY	METASTASES	CAUSE OF DEATH	TYPE OF TUMOR
		AFTER ONSET OF ILLNESS	AFTER DIAGNOSIS				
1909	40	3	0	Yes	0	Pneumonia	Carcinoid
1927	21	4	4	Yes	0	Pneumonia	Carcinoid
1934	19	2	⅓	Yes	0	Postop. sepsis	Carcinoid
1936	36	3	2	Yes	0	Postop. sepsis	Carcinoid
1936	67	½	0	Yes	0	Actinomycosis	Carcinoid
1941	32	4	⅓	0	—	Hemorrhage	Carcinoid
1941	43	14	4	Yes	0	Ca. of colon	Carcinoid
1943	29	14	6	Yes	1 Lymph node	Pneumonia	Carcinoid
1943	60	3½	3½	Yes	0	Ca. of stomach	Carcinoid
1945	61	28	7	0	—	Cardiac failure	Carcinoid
1947	40	19	2	Yes	0	Hemorrhage	Carcinoid
1948	46	8	3	Yes	0	Adrenal ca.	Carcinoid
1948	72	19	4	0	—	Pneumonia	Carcinoid
1951	66	7	3½	0	—	Cerebral hemorrhage	Carcinoid
1952	81	4	4	0	—	Arteriosclerotic gangrene of leg	Carcinoid
1953	48	13	13	Yes	Local	Recurrence of tumor	Cylindroma
1953	63	5	½	Yes	Local	Asphyxia because of tumor	Cylindroma

Survival of Untreated Patients.—One of the most useful yardsticks in measuring the malignancy of both the cylindroma and the carcinoid adenoma has been the analysis of what has happened to the untreated patients (Table III). Thirteen patients received either no treatment or palliative therapy in the form of repeated transbronchoscopic resections of the protruding intrabronchial tumor masses, or small doses of irradiation. Two of these patients had cylindromas of the trachea; one died shortly after an attempt to restore her airway by the insertion of a long metal tube, the other is living and appar-

TABLE III. SURVIVAL RATES IN YEARS FOR 13 PATIENTS WHO RECEIVED NO DEFINITIVE TREATMENT

	AFTER ONSET OF ILLNESS			AFTER DIAGNOSIS		
	SHORTEST	LONGEST	AVERAGE	SHORTEST	LONGEST	AVERAGE
Carcinoid adenomas (11 cases)	½	21*	8.4	0†	15*	3.1
Cylindromas (2 cases)	5	10*		½	5½*	

*Still living.
†Two were diagnosed at autopsy.

ently no worse more than five years after biopsy. Among the patients with carcinoid adenomas, there were two whose growths were found unsuspected at autopsy and three who are now living at six months, thirteen years, and fifteen years, respectively, after diagnosis by bronchoscopic biopsy. The remaining six have died, but survived for an average period of 4.1 years after diagnosis. One had a lymph node metastasis (Table II).

Results of Definitive Surgery.—Definitive surgery in this paper refers to the complete resection of the tumor and of any secondarily damaged pulmonary tissue when present.

The extirpation of the cylindroma is both difficult and disappointing. Two of our patients had inoperable growths. One survived a partial tracheal resection five years ago (two years after an attempt at local removal of the growth) and is alive and well seven years after diagnosis. The other returned to the hospital thirteen years after what appeared to be a complete extirpation of his tumor by pneumonectomy because of a widespread mediastinal recurrence, of which he died.

For the carcinoid adenomas the picture is different. There were no inoperable cases. Of the 43 patients who left the hospital alive after resections of their growths, 38 are living and well. Two of these patients had metastases at operation; two out of five lymph nodes contained metastases in one patient, one out of sixteen in the other. Both patients are alive and well, one seventeen years after operation, the other seven years after. They have been followed closely, both clinically and roentgenographically. (An analysis of the deaths has been given in Table II.)

Four patients had local resections, one through the bronchoscope, one by partial bronchial excision, and two by segmental resections. They are alive and well twenty-one, four, four, and three years, respectively, after operation.

For 19 patients with carcinoid adenomas, at least a year passed between diagnosis and resection. Nine were operated upon before two years had expired, one before three, and one before five. Four others delayed at least six years, and one seven years, before coming to surgery. The remaining three patients put off resection for eleven, fourteen, and twenty-one years, respectively. Among the 38 living patients there has not been a single demonstrable metastasis, nor an inoperable tumor, nor have any died of their disease. The length of survival after definitive surgery as well as from the time of diagnosis is shown in Fig. 9. There was a very significant increase in the number of patients who have had the opportunity to live five years if the time of diagnosis, rather than that of resection, was selected for the calculation of survival statistics. Yet, as contradistinct to the adverse manner in which prolonged delays between diagnosis and resection might affect the eventual outcome of patients with bronchogenic carcinoma, such delays among persons afflicted with carcinoid adenomas have caused no material change in the percentage of survivals. The number of the patients who might have survived 5, 10, 15, 20, or 25 years have been shown at the top of this graph based on the time of diagnosis and of resection. The actual number of survivors was consistently above 86 per cent for all periods and both groups. The number of patients upon whom the

statistics were calculated is too small to be of much value after fifteen years from the time of diagnosis or after ten years from the time of resection. Despite the small number of cases reported, the results are so consistent and so vastly different from those usually recorded for highly malignant neoplasms as to have considerable significance in characterizing the behavior of the carcinoid adenoma.

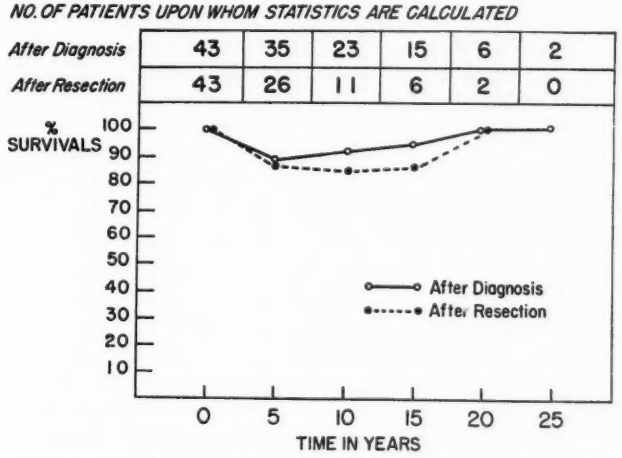

Fig. 9.—Survival rates for 43 patients receiving definitive surgery for carcinoid adenomas and leaving the hospital alive. In the row at the top of the graph is listed the number of patients who could have survived, based on the time of diagnosis; in the lower the number is based on time of operation.

CONCLUSIONS

In reviewing our small experience with the cylindroma, we have found that the histologic pattern of the tumor, characterized by ample evidence of mitoses and invasive qualities, has been reflected in its subsequent behavior. It is often so extensive as to be inoperable; it tends to recur and may have distant as well as local metastases. The experience of others has been similar.[2, 3] Although growing more slowly and metastasizing less frequently than the epidermoid carcinoma, its effect on the patient is ultimately deadly in a high proportion of cases. It remains to be proved whether intensive radiation will be helpful in controlling the cylindroma. Certainly, we cannot say that radical surgery will cure it, or that palliative measures are incompatible with prolonged life.

The carcinoid adenoma has always been a therapeutic problem because histologically it displays unmistakable evidence of a malignant potential, but behaves clinically in a fairly innocuous fashion. Our own experience has been illustrative of this paradox. About half of the tumors available for determination of this point showed local invasive qualities. Six contained demonstrable mitotic figures and one showed invasion of a lymphatic channel, but none were inoperable. Neither of the patients whose tumors and lymph

node metastases were resected has shown evidence of recurrence. Even the metastasis found at autopsy was single and would have been surgically resectable. There have been no distant metastases and none of our patients has died of his disease despite some prolonged delays in therapy. Most of the operative procedures employed for resection of the neoplasms were as limited as the anatomy or degree of pulmonary infection would permit.

In thoracic surgery the preservation of normal lung tissue is a primary consideration. Resections which will produce excellent survival rates and still conserve the patient's pulmonary reserve are ideal. Experience with local resections is limited, but encouraging.[4, 5] Thomas[6] reported only one recurrence after four local bronchial resections, and it was resectable by pneumonectomy. Several points are of importance when excisions by operations less extensive than a pneumonectomy are considered. First, diagnosis should be early by means of roentgenograms, followed by bronchoscopic biopsy if possible. The fact that 11 out of our 56 tumors originated in the secondary bronchi means that when encountered early in the disease fewer tumors will be observable endoscopically. The microscopic diagnosis, whether established preoperatively or when the chest is opened, must be unequivocally that of carcinoid adenoma. Local excision of tumors not in this group or of those containing tissue suspected of being bronchiogenic carcinoma may be unwise. The tumor must be grossly circumscribed and noninvasive in appearance. No gross evidence of lymph node metastasis should be present. The regional nodes should be removed for microscopic study. No area of irreversible pulmonary damage secondary to the tumor should be left behind. Finally, the patient should be followed at frequent intervals so that, if recurrence appears, further surgery may be undertaken. Many of the instances of metastasizing adenomas reported in the literature were actually cylindromas or tumors of an even more malignant nature. The fact that the carcinoid adenoma can invade or metastasize by the same routes as the bronchogenic carcinoma is of less importance than the fact that it rarely does so and therefore can usually be controlled by surgery.

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DISCUSSION

DR. CHEVALIER L. JACKSON, Philadelphia, Pa.—I quite agree with one of Dr. Soutter's latter statements regarding the importance of histologic diagnosis because I feel that the crux of the confusion is in the histologic diagnosis of bronchial tumors.

A series of our cases at Temple University Hospital was reported at San Francisco in 1950 and published in *Diseases of the Chest* in 1951. We had 40 cases at that time, 36 of the carcinoid and four of the cylindroma type. Now we have 14 more cases, all carcinoid,

constituting 5 per cent of the bronchial tumors seen in our clinic (900-odd since 1938). Six of these patients are dead; two of them, with the cylindroma type, died of asphyxia. They were inoperable in the beginning, so there was no mistake in choice of therapy. Two postoperative deaths were patients not operated on at Temple University Hospital. One died without even having a biopsy; the patient was in for diagnosis and had one aspiration but died of subsequent hemorrhage. Diagnosis was made at autopsy. One patient with the carcinoid type died of carcinoma of the mediastinum and esophagus, but the mediastinal metastasis probably was due to metastasis from a breast carcinoma rather than from the bronchial tumor which had been present for more than twenty years. We believe that one should individualize these cases in selecting treatment, and that exploration and resection should not be automatic, as in the case of carcinoma. But we have come to feel that about half the cases or more should be resected. For in patients who are getting along well enough but are still not free of the ailment, we have advised resection. Dr. Burnett and Dr. Rosemond have done a number of resections (lobectomies and pneumonectomies) with no operative mortality. We have seen no metastases in our series. But we do not agree that only the "bad risks" are suitable for bronchoscopic resection, because we have a number of cases in our follow-up now which have been treated successfully by bronchoscopic resection alone.

DR. RICHARD H. OVERHOLT, Boston, Mass.—We will all agree that whenever a chest is explored for neoplastic disease, the surgeon hopes for the sake of the patient that the cards will not be histologically stacked against him. Dr. Soutter, in his very inclusive and complete report of the experience at Massachusetts General Hospital, certainly shows that this is an entirely different type of tumor from the common bronchiogenic carcinoma. A number of early reports on cure rates in carcinoma undoubtedly included some of these cases, and we were guilty of including some in our early reports. In fact, before the meeting of this Association twenty years ago, in Boston, I presented two cases treated by pneumonectomy, thinking they were carcinomas. Later Dr. Shields Warren reviewed the histologic evidence and reclassified these two early cases as adenoma. Our experience shows that of the total number of primary neoplastic tumors of the lung, approximately 4 per cent, have been adenomas.

During the period 1931 to 1953, we have treated 51 cases of bronchial adenoma. Of these, 47 patients are still living and 4 are dead. There were 2 operative deaths and 2 late deaths—one of metastatic disease and one of carcinoma of the bladder. Two cases were treated by bronchotomy, 1 by simple enucleation of the peripheral lesion, 19 by lobectomy, and 29 by pneumonectomy.

I should like to discuss 2 cases, the largest and then the smallest adenoma we have encountered. I think Dr. Jackson will agree that in this first case it would be a little difficult to resect the tumor via the bronchoscope. There was a small portion projecting within the lumen, but the principal mass of tumor was peribronchial, as most of them are.

In the x-ray of the smallest lesion, there was evidence of basal segmental atelectasis. We expected to have to do a segmental resection or lobectomy. On bronchoscopy, a highly vascular tumor was found. It was unwise to take bronchoscopic biopsy.

Upon exploration and bronchotomy, we found a small tumor almost entirely within the lumen, but involving a 3 to 4 mm. portion of the bronchial wall. There had been no permanent damage to the distal segments, so local excision was possible.

Two years later conservation of the left lung was noted from x-rays taken.

DR. GABRIEL P. SELEY, New York, N. Y.—I should like to report, briefly, a rather unusual case of adenoma of the bronchus. This was in a woman 20 years old who had symptoms of respiratory tract bleeding for a period of six months. No cough or other symptoms were associated with the bleeding. Several days before she was first seen she suddenly realized she had blood in her mouth without cough. She was thoroughly investigated, and x-ray of the chest was negative. On the first bronchoscopy it was noted that she had a large tumor of what was thought to be the trachea. This was biopsied and was first reported as adenocarcinoma. On rebronchoscopy and more careful examination it was noted that this tumor resembled an adenoma. Biopsy at this time showed a typical adenoma which was treated by bronchoscopic fulguration. After several treatments it was noted that the tumor arose from the carina and appeared to extend up along the posterior wall of the trachea. It did not extend into either bronchus. Following one of the fulgurations the patient developed an

episode of fever and atelectasis, and bronchoscopy at that time showed that part of the eschar had dropped down into the right main bronchus and obstructed it. After removal of the eschar the patient did well. Now, six months after treatment started, a biopsy taken at the site of the original tumor is negative for adenoma.

This patient has had numerous studies including tomography in order to rule out any evidence of extratracheal or extrabronchial neoplasm, and so far there has been no evidence of it. The question I would like to raise at this time is whether this is the proper treatment for this type of case.

DR. ALFRED GOLDMAN, Beverly Hills, Calif.—Dr. Soutter was kind enough to mention a case which we had reported of bronchial adenomas with intraluminal invasion of a pulmonary vein, and I wish to report the follow-up on another case (K. F., S-362-48).*

This was a woman in her thirty's, with a "mixed tumor" type of bronchial adenomas which required resection of the right lower and middle lobes. We had no evidence of metastasis at the time the case was reported, and the operation was done Jan. 29, 1948. Last March, five years postoperatively, the patient returned with a markedly enlarged liver, although the lungs were clear. An abdominal exploration was done and metastatic disease of the liver was found. Biopsies of the liver were consistent with the original bronchial tumor. These follow-up findings are of interest because the pathologist's examination of the original tumor disclosed a marked degree of local invasion and contiguous infiltration through the bronchial wall, to a bronchial lymph node, and to the wall of the inferior pulmonary vein.

This case demonstrates again the potential malignancy in bronchial adenomas for distant metastases and the necessity for observing adenomas with local invasion for distant metastases, especially in the liver, after five years or more. As Dr. Soutter said, this apparently does not happen in the carcinoid variety as it did in this one with a histologic diagnosis of "mixed tumor" of the adenoid cystic type.

DR. OSLER ABBOTT, Emory University, Ga.—I wish to discuss briefly experiences with three carcinoid adenomas arising on the carina. Each of the three was treated by a different method. The first was in a young child with known obstructive symptoms for four years. A pedunculated adenoma was excised bronchoscopically in 1947, and she is now without evidence of recurrence. The second was an extensive adenoma involving the right upper lobe bronchus going across to the carina. It was treated in 1947 by total right pneumonectomy, removal of the tracheal wall and the contralateral medial wall of the left main stem bronchus, and reconstruction by plastic closure. That patient lived for four years and died from extensive metastatic disease of the liver. The third patient had a localized process involving the carina and adjacent left main stem bronchus. This adenoma was resected and repaired by dermal graft. This exemplifies three different methods of handling carinal carcinoma and preventing death from suffocation. Extensive reconstruction can be carried out with internally, firmly-supported dermal graft to maintain the support previously provided by the cartilaginous elements in the carina.

DR. LAMAR SOUTTER (Closing).—In answer to Dr. Seley's question, fulguration has been useful in destroying the base of tumors that have been partially removed bronchoscopically when they had no extrabronchial extension. Occasional complications, including fatal hemorrhages, have occurred from this treatment.

In reply to Dr. Jackson, it seems to me that as long as we know that a large number of these tumors go through the wall of the bronchus, it is wiser to do a bronchotomy in a good-risk patient and excise the wall, than attempt to excise it transbronchoscopically. Three of our patients, whose tumors had apparently been completely removed bronchoscopically, had such a severe degree of sepsis in their lungs following treatment that they needed transthoracic resection. I am not, therefore, very optimistic about that type of treatment.

I am pleased to see that Dr. Overholt has done some bronchotomies for carcinoid adenoma, because I feel that there is a place, although a limited one, for such operations,

*J. THORACIC SURG. 18: 141, 1949.

PALLIATION OF ESOPHAGEAL OBSTRUCTION DUE TO CARCINOMA WITH A PERMANENT INTRALUMINAL TUBE

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Chicago, Ill.

RESECTION of the esophagus is feasible only in approximately one-third of the cases of carcinoma of this organ. The rate of unresectability rises with the anatomic height of the lesion because of involvement of contiguous vital structures, primarily the bronchus and the aortic arch. Extirpation of the diseased segment, thus, is impossible frequently, even for the sole purpose of palliation of obstruction without the expectation of cure. The esophagus, particularly in the upper region, does not lend itself readily to short-circuiting procedures to by-pass the obstructed site, as does the lower alimentary tract. A gastrostomy or a jejunostomy is the usual alternative to death by starvation. Either procedure leaves much to be desired from the standpoint of mechanical function as well as esthetic appeal. Gastrostomy or jejunostomy, moreover, does not affect the distressing symptom of salivary overflow resulting from obstruction. A disinclination to perform either procedure is furthered by its attendant mortality risk, which is not inconsiderable. An average of operative mortality rates for palliative gastrostomy exceeds 45.0 per cent.[1, 2] A gastrostomy of such nature is most frequently performed subsequent to a thoracotomy, where the unresectable state of the lesion first is found. The patient is thus exposed to the operative risks of both procedures.

A review of published reports indicates that esophageal resection, too, is primarily a procedure of palliation. That palliation rather than cure is the expectation is supported by a study of the results (Table I).

Survival Rate.—There is recorded one five-year survival following resection for carcinoma of the middle and upper portion of the esophagus. This is reported by Sweet[3] as the single surviving patient of a total of 107 cases of carcinoma involving this region. As to lesions of the lower end, including those involving the cardia of the stomach, Table I shows that 27 five-year survivors are reported following extirpation. This includes one case of one of the authors. Thus, out of a total of over 2,500 cases of carcinoma of the esophagus, 28 patients have survived for a period of five years or more.

Resectability.—Reference to Table I shows that the over-all rate of resectability for carcinoma of the esophagus is computed at 35.0 per cent. Although

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a scrutiny of the reported figures does not permit an interpretation according to the location of the lesion, it seems certain that the rate of resectability for carcinoma of the middle or upper portions falls far below that for the esophagus as a whole.

TABLE I. REVIEW OF SOME RESULTS OF RESECTION FOR CARCINOMA OF ESOPHAGUS

	NUMBER OF CASES		RESECTABILITY (%)	OPERATIVE MORTALITY (%)	SURVIVORS (NO. OF YEARS) 5	4	3	2	1
Sweet[3]	Mid and upper	107	65.0	24.3	1				
	Lower and cardia	147		11.6	11				
Wu and Loucks[4]	Mid and upper	172	47.1	27.3	0				
	Lower and cardia			16.6	2				
Garlock and Klein[5]	Mid and upper	457 (401			0				
	Lower and cardia	operations)			11				
Resano[6]	1,000				2				
Author (S. A. M.)					1				
Humphreys and Moore[7]	162 (54 resections)		33.3	45.7	0	1	1		
Parker et al.[8]	170 (30 resections)		18.0	57.0	0	1			
Puestow and Cross[9]	80 (37 resections)		46.0	33.0	0				4
Strieder[10]	Mid and upper	72		55.5	0				
	Lower and cardia			12.0					
Ravitch et al.[11]					0				
Meade and Rasmussen[12]	28		32.0		0				
Santy et al.[13]	70		8.5		0				
Cook County Hospital (All services) (1951 and 1952)	Mid and upper	123 (42	36.2	80.7	0				
	Lower and cardia	resections)		68.7	0			1	

Resectability, average 35.0 per cent; operative mortality, average approximately 40.0 per cent; 28 five-year survivors out of a total of over 2,500 cases.

Operative Mortality.—Reported rates of operative mortality range from a low of 11.6 per cent to a high of 80.7 per cent. Mortality rates for resection of the upper and mid-esophagus are consistently greater than those for the lower region. The over-all mortality rate for the esophagus as a whole is computed at approximately 40.0 per cent.

In view of the foregoing, it seems unreasonable to subject a patient to the hazards of esophageal resection except for the prospect of cure. When the eradication of carcinomatous tissue cannot be accomplished, and palliation alone is the aim, it would appear logical to choose a simpler procedure instead of resection and esophagogastrostomy.

A procedure which would permit food to pass through the site of carcinomatous obstruction would solve the problem of palliative alimentation. Such a method was designed and has been used in nineteen operative instances over a period of nine months. The procedure is performed at the time of thoracic exploration, when it is found that the lesion cannot be extirpated, or instead of a resection and esophagogastrostomy to be executed purely for the purpose of palliation.

The method consists of locally intubating the esophagus at the site of neoplastic constriction with a tube designed for this purpose (Fig. 1). The latter is passed into the lumen through an incision in the normal esophageal

wall immediately above the lesion and, after having been threaded through the stenotic segment, is left in place as a permanent prosthesis. An artificial lumen is therefore constantly maintained in spite of the continued growth of the tumor.

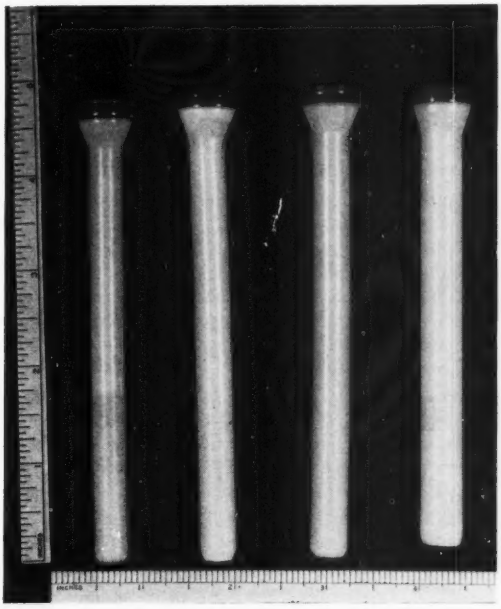


Fig. 1.—Photograph of a set of esophageal tubes or prostheses, showing graduation in size from 0.9 to 1.2 cm. in diameter.

OPERATIVE TECHNIQUE

Lesions involving the upper two-thirds of the esophagus are approached by way of a right thoracotomy, usually through the bed of the sixth rib. The lower portion of the esophagus is exposed by means of a left thoracotomy after resecting the eighth rib.

Except for its lower portion, the esophagus is essentially a resident of the right hemithorax, and lends itself more readily to surgical manipulation through this route. The azygos vein, as it crosses the mediastinum to join the superior vena cava, is the only structure which may hinder free access to the esophagus. It is promptly ligated and divided if it lies within the operative field. A segment of normal esophagus, approximately 2 inches above the lesion, is selected for the site of the esophagotomy. It is unnecessary to mobilize the esophagus any more than is needed for encirclement by a Penrose drain for stabilization. Needlessly stripping it from its bed denudes the organ of some of its vascular supply, thus affecting its healing potential, to favor fistula formation. A longitudinal incision, approximately 1 inch in length, is made through the muscular coat. The mucosa is then transfixed between two stay sutures and incised to open into the lumen. It is of importance to secure the mucosa firmly in this fashion so that the true lumen is opened. Because of the loose nature of the tissue which binds the muscularis to the mucosa, a false lumen is easily created by dissecting between these two layers. The esophagus is, in reality, a mucosal tube lying loosely within a muscular tube, and is so designed, possibly, to accommodate itself to sudden dilatations imposed by variations in the size of the food bolus.

An estimate of the degree of esophageal constriction is obtained by passing graded catheters. These are inserted into the lumen through the esophagotomy, and are directed caudally to the area of involvement. If the patient still had retained the ability to swallow liquids, the obstructed site will usually allow the passage of a No. 14 Fr. catheter. Graduated common duct dilators are then passed to enlarge the channel to the greatest possible width. Caution must be exercised not to mistake a blind recess in the tumor mass for the true lumen when forcing through the dilating metal tip. The rubber catheter is re-employed to explore the channel for assurance. The lumen usually can be made to accept a No. 8 to No. 10 common duct dilator. A Levin tube is then passed through the compromised region, in like manner, and is directed into the stomach. The prosthesis is threaded over the Levin tube and, using the latter as a guide, is pressed through the stenotic segment until its upper, flared cuff rests upon the tumor mass, which prevents its further passage (Fig. 2, *A*, *B*, and *C*).

The proximal end of the Levin tube is then passed into the esophageal lumen and is directed toward the mouth, where it is retrieved by the anesthetist. It then may be drawn out through the nose by means of a catheter.

The esophagotomy incision is closed in two layers, mucosa and muscularis, using interrupted sutures of fine silk. A periesophageal ligature of heavy silk is now placed at a level immediately above the upper, flared cuff of the intubating tube, which can be palpated through the esophageal wall. This encircling ligature is drawn snugly enough so that the esophageal wall will be indented sufficiently to retain the tube and prevent its expulsion in the event of emesis, yet not so tight as to obstruct the lumen (Fig. 2, *D*).

It is to be emphasized that this retaining ligature is completely extraesophageal and does not pierce the wall. It is felt that the wall of the esophagus should not be transfixed by heavy, nonabsorbable sutures to secure an artificial, intraluminal device. It is believed that the intramural portion of the suture, weighted by the anchored, indwelling contrivance, would act as a drain and encourage the development of a permanent fistula.

The following details in the operative technique are also referred to as factors of importance in the prevention of fistulas. The site for the esophagotomy is chosen well above the lesion. The incision is thus made in mural tissue uninvaded by carcinoma, and hence has its reparative qualities unimpaired. This location also permits the prosthesis to slip down and away from the site of esophagotomy, thus avoiding persistent contact between the retained foreign substance and the inner surface of the healing wound. The periesophageal ligature is fixed solely to indent the esophageal wall *above* the upper rim of the prosthesis, and does not embrace the latter. This eliminates the possibility of strangulation of esophageal tissue between the external ligature and the unyielding tube within.

The nasogastric tube is retained until the sixth postoperative day, at which time it is withdrawn to allow the assumption of a semiliquid diet. Gastric suction is maintained for the first twenty-four-hour period, following which the tube is utilized for the purpose of feeding.

In some instances, a tumor involving the upper esophagus may project into the superior thoracic strait, thus making it impossible to gain access to a normal segment above the lesion. In such a situation, the operative procedure is reversed. The esophagus is incised *below* the region of involvement, and the Levin tube is passed toward the mouth first. The prosthesis is then guided in the oral direction and is pressed through the tumor. The cuff now faces in reverse of the usual direction, but the tube is prevented from slipping to the stomach by a periesophageal ligature placed below.

CASE REPORTS

The following reports have been selected as illustrative of the cases in which surgical intubation of the esophagus has been performed.

CASE 1.—L. B. (No. 4), a 58-year-old man, was admitted to the Cook County Hospital, July 20, 1953, complaining of inability to swallow solid food for six weeks, and of weight loss of 30 pounds. An esophagogram disclosed an ostructing lesion at the mid-esophageal

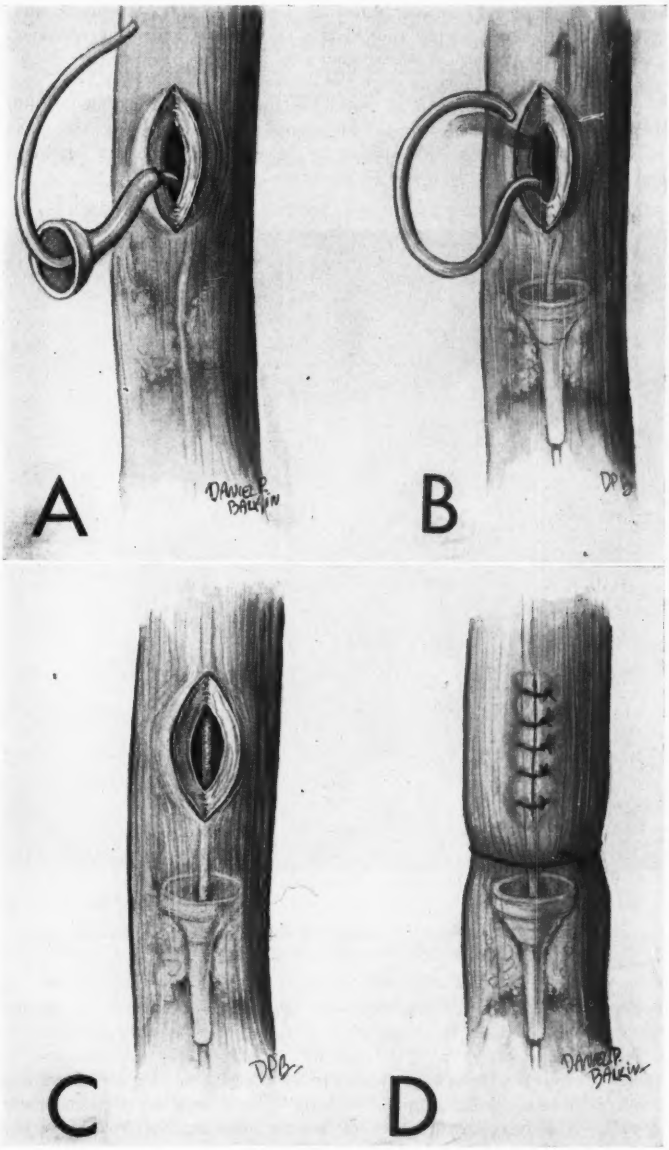
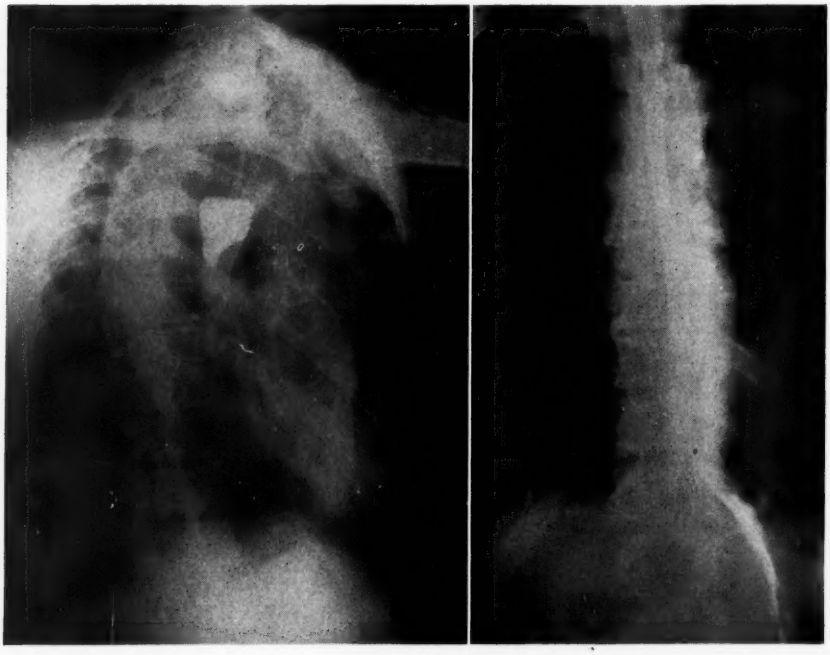


Fig. 2.—Drawing to demonstrate operative technique. *A*, A Levin tube has been passed through the carcinomatous region to the stomach via an esophagotomy. An esophageal tube or prosthesis has been threaded over the Levin tube. *B*, Using the latter as a guide, the prosthesis has been pressed through the obstructed segment. Its cuff rests upon the tumor mass, preventing complete passage. *C*, The proximal end of the nasogastric tube has been directed to the mouth. *D*, The esophagotomy has been closed. An extramural, periesophageal ligature has been placed to prevent oral expulsion of the prosthesis by indenting slightly the esophageal wall above this level.

region (Fig. 3). On August 19 an esophagoscopy was done, and a carcinoma was found 26 cm. from the upper teeth. A biopsy showed this to be an "infiltrating squamous-cell carcinoma." Operation was performed on September 4.

A right thoracotomy was done through the bed of the resected sixth rib. The intention was that if the lesion were found to be resectable, and there existed the possibility of an anticipated cure, then the abdomen would be opened and the stomach, after having been freed from its anatomic attachments, would be passed into the right hemithorax where resection and esophagogastrostomy would be performed.



A. *B.*

Fig. 3.—Case 1. *A*, Preoperative esophagogram, showing complete obstruction of radiopaque mixture; *B*, Esophagogram taken after operative intubation, demonstrating patency of the esophagus.

At operation, the carcinoma was found to involve the esophagus at the level of the azygos vein and to extend for a distance of 3 inches distally. The tumor involved the contiguous mediastinal tissues, including the left bronchus and the vertebral bodies. A segment of normal-appearing esophagus proximal to this site was exposed after ligating and dividing the azygos vein. A longitudinal incision 1 inch long was then made through the esophageal wall. The inferior extremity of this incision was at least 1 inch above the pathologic zone. Insertion of the plastic tube designed to remain as the permanent prosthesis was then accomplished by the technique previously described. The chest was closed after placing a catheter for water-seal drainage of the pleural cavity.

Gastric suction was maintained for the first twenty-four hours, after which the tube was utilized for gavage. It was removed six days later, after which the patient swallowed a semiliquid diet without difficulty. The sense of well-being which this patient expressed upon being able to swallow once again was most gratifying.

He was discharged from the hospital on October 3 after a gain of 10 pounds in weight. He was seen two weeks later, at which time he had gained an additional 6 pounds. When last seen, March 23, 1954, his weight had begun to decrease, although his ability to swallow remained unaffected. He complained of increasing weakness and beginning hoarseness.

CASE 2.—H. A. (No. 8), a 50-year-old man, was admitted to the Cook County Hospital on Oct. 5, 1953, complaining of dysphagia and weight loss of 20 pounds in six weeks. His dysphagia had progressed rapidly, so that shortly after his entrance to the hospital he experienced marked difficulty in swallowing liquids. An esophagogram showed complete obstruction at the lower portion. Esophagoscopic examination showed a large carcinoma 36 cm. from the upper teeth. Because of dehydration, inanition, and marked disturbance of electrolyte balance, it was necessary to administer multiple blood transfusions and intravenous replacement therapy. Operation was performed on October 21.

The left pleural cavity was opened through the bed of the resected eighth rib. The distal end of the esophagus was massively involved with carcinoma. The diaphragm at the hiatus was bulged upward by a solid, unyielding tumor mass which involved the infradiaphragmatic region, including the cardia of the stomach. Resection was not feasible. Accordingly, a segment of normal-appearing esophagus superior to the cancer-bearing area was selected and its lumen opened. After dilatation of the constriction with common duct dilators, a Levin tube was passed downward into the stomach. The tube to be permanently retained was then threaded over the Levin tube and pressed through the carcinomatous segment. Gastric content began to regurgitate through the tube. The other end of the Levin tube was then guided up the esophagus, and the esophagotomy closed as previously described. A periesophageal ligature of silk was placed to prevent oral expulsion of the tube. The chest was then closed after inserting an intercostal catheter for closed drainage.

The nasogastric tube was removed six days later and the patient began to swallow semisolid food without difficulty. He was discharged from the hospital on November 10. His only complaint was gaseous eructation and "water-brash," that is, the regurgitation of small mouthfuls of gastric fluid, which was particularly noticeable upon reclining. The avoidance of a recumbent posture after eating greatly helped this disturbance. At the latest report, March 31, 1954, this patient was still living.

CASE 3.—E. M. (No. 6), a man 60 years of age, was admitted to the Cook County Hospital Aug. 28, 1953, complaining of weight loss of 25 pounds and dysphagia for a period of two months. He retained the ability to swallow only liquids. An esophagogram disclosed an obstructive lesion at the region of the middle third. An esophagoscopic examination showed a carcinoma 30 cm. from the upper teeth, which, upon biopsy, proved to be "horni-fying squamous cell" in type.

A right thoracotomy was performed on September 25, and the pleural space opened after resecting the sixth rib. The tumor was found to be fixed to the contiguous mediastinal structures. An esophagotomy was made above this area, and an esophageal tube inserted in the manner previously described. He recovered uneventfully and started to swallow without difficulty after removal of the nasogastric tube on the sixth postoperative day. He was discharged from the hospital on October 16.

The patient returned to the hospital on October 30 in a state of severe dehydration. He stated that he had vomited an esophageal tube three days prior and had been unable to swallow any liquids, including water, for a period of three days.

After restoration of electrolyte balance by intravenous solutions, reoperation was performed on November 11. The same tube was reinserted by means of a right thoracotomy in a manner identical to his previous operation. He resumed swallowing without difficulty once again and left the hospital on November 21.

The patient was readmitted on Feb. 17, 1954, complaining of marked weakness. He had lost approximately 10 pounds in the preceding month. He still retained the ability to swallow liquid and soft foods, but not with the same gusto as before. There was no

apparent obstruction. Although he continued to swallow a liquid diet, his condition continued to deteriorate and he died March 6, 1954. Permission for a post-mortem examination could not be obtained.

RESULTS

Transthoracic intubation of the esophagus with a permanently indwelling tube to palliate the obstructive effects of carcinoma has been performed in 19 instances upon 18 patients.

One patient required reoperation (Case 3). He vomited his tube sixteen days after the first insertion and shortly thereafter became almost completely obstructed. He was readmitted to the hospital, and, following operative replacement of the tube, he resumed swallowing without difficulty.

In one case intubation could not be accomplished because of massive involvement of mediastinal lymph nodes, which precluded any type of esophageal dissection. This case has been excluded from consideration.

While a total of 19 operative cases constitutes an extremely small series, and although only nine months have elapsed since the inauguration of the procedure, it is believed that a review of the results at this time is of value. In assessing the results of surgical intubation, a comparison may be made with the alternative palliative procedure of gastrostomy or jejunostomy from the standpoint of operative mortality and survival time. Consideration must be accorded the fact that, whereas the latter constitutes a second operation with a mortality rate separate from that of the preceding primary thoracotomy, surgical intubation combines, as it were, exploration and palliation in a single procedure.

In the course of performing 19 transthoracic intubations of the esophagus, there occurred 6 deaths which are computed as operative mortality (31.5 per cent). A fatality occurring within thirty days of the time of operation is considered as an operative death. Two of these were incurred accidentally and were not directly related to the operation. Upon his return from the operating room, oxygen was connected to the Levin tube, in one case, on the mistaken assumption that the tube was for the purpose of supplying intranasal oxygen. The mistake was detected upon the appearance of massive tissue emphysema. Post-mortem examination disclosed a ruptured stomach. The second patient, a 71-year-old man, slipped and fell while attempting early ambulation. He suffered a head injury and a fracture of the humerus. He died three days later.

The demise in two cases was due to cardiovascular failure. In one, heart block and failure occurred twenty-four hours following surgery. In the other, death occurred nine days after intubation. A previous abdominal exploration disclosed an unresectable carcinoma of the stomach with massive involvement of the cardia, contiguous tissues, and the distal end of the esophagus. Thoracotomy with intubation was performed ten days following the laparotomy because of complete obstruction. Although this was completely palliated, he died suddenly while sitting at his bedside. A post-mortem examination gave no clue as to the cause of death. The surgical site was clean and the esophagus was intact. Death was attributed to sudden cardiovascular failure. The patient was 79 years of age.

The remaining two patients died seventeen and nineteen days, respectively, after surgery. Although clinically well and without postoperative complications, the free imbibition of an abundant liquid and semiliquid diet did not stem a gradual but steady decline in weight and strength. It is probable that the constitutional effects of the carcinoma had progressed to the critical point of no return, so that weight loss and debilitation continued even though ingestion of a diet adequate in calories was made possible.

There were twelve surviving patients who received the palliative benefits of esophageal intubation. Of these, five have succumbed to the inexorable progression of their primary disease. Their ultimate termination was due to generalized debilitation and asthenia, although alimentary patency was maintained to the end. In Table II is listed their individual survival times following surgery. The mean is computed as 3.4 months.

TABLE II. SURVIVAL PERIOD OF PATIENTS SINCE DEAD

CASE NO.	DATE OF INTUBATION	DATE OF DEATH	SURVIVAL PERIOD (DAYS)
2	Aug. 26, 1953	Oct. 7, 1953	42
6	Sept. 25, 1953	March 6, 1954	162
9	Oct. 30, 1953	March 21, 1954	142
11	Dec. 2, 1953	March 15, 1954	103
15	Dec. 30, 1953	March 9, 1954	69

Total number of cases: 5; average survival period: 103 days or 3.4 months.

Table III shows the individual survival time of seven patients who have not as yet succumbed to the disease. Thus far, the mean survival time of this group is 4.0 months. This figure has small meaning at present. By interpolation, one must recognize that the ultimate survival time will far exceed 4.0 months, inasmuch as these patients are still living, some having been operated upon only recently and therefore having a greater expectation of longevity. The longest period of life, thus far, from the time of intubation, is 207 days.

TABLE III. SURVIVAL PERIOD OF PATIENTS THUS FAR STILL ALIVE

CASE NO.	DATE OF INTUBATION	SURVIVAL PERIOD (TO MARCH 31, 1954) (DAYS)
4	Sept. 4, 1953	207
8	Oct. 21, 1953	130
10	Nov. 6, 1953	145
13	Dec. 15, 1953	116
14	Dec. 16, 1953	115
17	Jan. 16, 1954	73
18	Feb. 10, 1954	49

Total number of cases: 7; average survival period: 120 days or 4.0 months.

In comparison, the average survival period following thoracic exploration alone, for unresectable carcinoma of the esophagus, is 1.7 months, as computed by Wu and Loucks.[4] Following gastrostomy, the average period of survival is 2.2 months, as reported by the same authors.

Complications encountered were: fistula formation and empyema, passage of the tube into the stomach, vomiting of the tube, obstruction due to impaction of food within the tube, and "dyspepsia."

An esophagopleural fistula, empyema, and passage of the tube into the stomach all occurred in one case. This patient had a massive carcinoma involving the cardia of the stomach and the lower end of the esophagus, with complete obstruction. At operation, great difficulty was experienced in attempting to pass catheter or metal dilator from the esophagus into the stomach through the carcinomatous region. The diaphragm was incised so that the stomach might be palpated to ensure proper guidance of the dilator as it was forced through to create a passageway from esophagus to stomach. A left empyema developed which was treated by open drainage sixteen days following intubation. He returned to the hospital thirty-five days following the original operation because of increased drainage. This was due to a fistula which later healed after tube-feeding via a Levin tube. He resumed eating, but his condition regressed, and he died sixty-nine days following the operation for intubation. At post-mortem examination, the intubating tube was found lying in the stomach. A roentgenogram one week prior to this showed the tube to be retained in its proper position at the cardia.

As a contributing cause for fistula formation, it is felt that the esophageal incision was made too close to the lesion so that the inferior portion of this wound was through mural tissue containing carcinoma. Care is now exercised to locate the esophagotomy farther cephalad, allowing 1 to 2 inches of normal-appearing esophagus to intervene between it and the upper margin of the tumor.

One patient vomited his tube sixteen days after insertion. It was replaced by reoperation. This has been previously mentioned.

In two cases, obstruction followed impaction with food. The patient has no subjective sensation of the presence of a permanent tube and there is no interference with deglution. It is, therefore, difficult to convince him, once he finds himself capable of swallowing again, to refrain from partaking of anything but a semiliquid diet. Two such patients, who remained recalcitrant to all adminitions of caution, finally obstructed their artificial passageways. Some of the impacted food could be removed via the esophagoscope. Eventual patency was achieved by digesting the remaining impaction by swallowing solutions of proteolytic enzymes such as Caroid and Papain, which are used as commercial meat tenderizing agents.

Regurgitation of small quantities of gastric content and the sensation of "heartburn" have occurred following palliation for obstruction at the cardia. These symptoms are attributable to the permanent nature of the patency between the esophagus and the stomach, effected by the indwelling tube. The esophagus and the stomach are now, in effect, one single hollow viscus due to the loss of the sphincteric mechanism of the cardia. Eructation of gas may bring with it small quantities of liquid gastric content. A reclining position, particularly when adopted shortly after a liquid meal, favors gravitational spill into the esophagus. The maintenance of an upright position, especially after eating, has helped greatly in ameliorating these symptoms of "dyspepsia."

Post-mortem examinations were conducted in five cases. Previous mention has been made of one fatality in which there appeared an empyema, healed esophageal fistula, and the presence of the tube lying free within the stomach.

In the remaining four instances, the surgical sites and the retained tubes were found intact and uninvolved. There did appear, in one case, a small mucosal erosion at a point of contact between the free terminal portion of the tube and the epithelium. This occurred in a case early in the series. At that time the tubes were more rigid in texture, and the fact that they were fashioned manually by one of the authors did not lend to the artistry of their finish. No further ulcerations were found after the adoption of a tube more yielding, yet incompressible in nature, and commercially manufactured.*

DISCUSSION

The maintenance of a passageway through the substance of carcinoma tissue by means of a tube has been described by other authors. In 1927 Souttar[14] passed metallic tubes through malignant constrictions by means of an esophagoscope and obtained satisfactory patency in this fashion. More recently, Allison,[15] after condemning gastrostomy or jejunostomy as a palliative measure because of the considerable mortality, discomfort, and proved inadequacy in prolonging life, has revived the use of Souttar's method. Ravitch[11] reported the operative utilization of a plastic tube, in one case, where resection was not feasible. Brown,[16] in a similar case, described the use of a metallic tube to maintain patency.

A tube of plastic material for use in the surgical treatment of carcinoma of the esophagus has been described by Berman.[17] The principle underlying utilization of this appliance is not to be confused with that of this presentation. In the technique described by Berman, the tube is used to *replace* an extirpated segment of carcinoma-bearing esophagus and is substituted to bridge the gap. The operation is thus a resective procedure, designed for curative purposes, and vies with esophagogastrostomy in this value. In contrast, surgical intubation, as previously described, is used solely for palliation when resection is not advisable or cannot be accomplished.

Trial of the technique of intubation as presented here was first prompted by the sense of frustration and helplessness in the face of inextricable lesions of the esophagus, usually in the upper and middle regions, which precluded resection even for the sole purpose of palliation. Whereas surgical intubation was first reserved for such situations, the indication for its use was broadened to include lesions which were technically resectable, but where complete eradication of the neoplastic process, in accordance with the basic principles of surgery for carcinoma, could not be anticipated. In such instances, where the relief of obstruction rather than the prospect of cure was the consideration, the issue as to the choice of the palliative surgical procedure was frequently resolved in favor of the simpler one; namely, intubation rather than resection. Because of the rapidity and uninvolved nature of the dissection, too, many who otherwise would have been rejected as unsuitable candidates for a contemplated resection were found capable of tolerating this procedure. Indeed, several of the patients comprising the group herein reported, previously had been excluded from consideration for thoracotomy because it was feared that

*Manufactured by Davol Rubber Co., Providence, R. I.

they could not withstand resection, even if feasible. Instead, a gastrostomy or jejunostomy was done. They were later chosen as the original candidates for thoracotomy and intubation because of a poorly functioning alimentary vent, and a progressive course of clinical deterioration.

SUMMARY AND CONCLUSION

A method is described whereby palliation of obstruction, due to carcinoma of the esophagus, may be achieved by the introduction of a permanently indwelling tube. The tube is surgically inserted at the time of thoracic exploration when it is determined that resection of the esophagus is not feasible.

It is suggested that, because of its simplicity, the method might profitably be substituted for resection and esophagogastrostomy, in many instances, when the latter is performed purely for palliative purposes with no prospect of eradicating the disease process.

It is felt that surgical intubation is superior to the alternate palliative procedure of gastrostomy or jejunostomy in that it may be performed at the time of the original thoracic exploration, thus avoiding an additive operation, that it adds to the well-being of the patient by permitting him to swallow, that it eliminates the discomfort of abdominal tube feeding, and in that it prevents the distressing symptom of salivary overflow resulting from esophageal obstruction. A study of eighteen cases over a period of nine months further suggests that the survival time is greater than that accorded by gastrostomy, although it is realized that the size of the series and the brevity of the time that has elapsed do not justify definitive conclusions as to the ultimate results of this procedure.

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DISCUSSION

DR. E. B. BENEDICT, Boston, Mass.—Dr. Mackler made the statement that "a gastrostomy or a jejunostomy is the sole alternative to death by starvation." I must say I cannot agree with that because we have many patients who are well palliated by swallowing a thread and using the thread as a guide to bouginage and combining that with x-ray treatment. I have three such patients under treatment at the moment, and they are eating everything. I should also like to mention that his method was thought of years ago by Souttar,* who used a coiled nickel or German silver wire introduced through a large esophagoscope. Souttar's method not infrequently failed owing to perforation or esophagotracheal fistula. I am convinced that x-ray treatment and bouginage offer the best palliation in inoperable carcinoma of the esophagus, and I am also certain that gastrostomy is undesirable and almost never necessary.

DR. MAX G. CARTER, New Haven, Conn.—I could not agree more with any statements about the distressing effects of gastrostomy than those of Dr. Mackler. I would like to report very briefly our own experience. During the past four years we have been utilizing endoscopically such polyethelene tubes, because, in far the greater percentage of these patients, if they are inoperable, the inoperability can be determined before thoracotomy. So far as I know the first person to do this was Dr. Souttar in England many years ago, using metal tubes. I am sure that Dr. Jackson and Dr. Benedict, having extensive experience, might comment on it further.

We fashioned tubes of polyethelene with the ends flanged. We have these ready for all endoscopies in cases with carcinoma, where there is a strong suspicion that it may be nonresectable because of the advanced stage or advanced heart disease, or extension into the trachea.

In many cases it is necessary to introduce a small No. 8 or No. 9 Fr. Jackson dilator, to feel the lumen. There may be no actual lumen until you dilate it a bit. Then the tube is passed over the dilator through the esophagoscope, pushing with the suction tip, and frequently it is necessary then to spread the flange with an alligator forceps.

We have one x-ray of tubes at the thoracic inlet. On the left it shows the tumor, and on the right the tube is in place. It is marked at its upper end by a few turns of stainless steel wire in order to radiographically identify it.

At the other end of the esophagus there was a carcinoma of the gastric cardia which was almost totally obstructing the esophagus and was found nonresectable by virtue of direct extension into the aorta. Therefore a tube was passed. We have placed them at all levels of the esophagus; the greatest difficulty is encountered in patients of advanced age with kyphosis in whom it may not be possible to get the esophagoscope down beyond the level of the aortic arch. In such cases one cannot use this method.

In summary, we have used this method during the past four years. We have attempted polyethelene intubation in 20 patients; it has been successful in 14. In the other 6, because of the reasons I have described, we were not able to introduce the tubes. We have had no instances of esophageal perforation. In one case the tube has slipped down part way and the tumor obstructed it above; we introduced another tube on top of it and it worked effectively. In two cases we have given radiation therapy, which we are now using more extensively. In one case there was so much postradiation necrosis of the tumor that the tube slipped completely through, but was passed uneventfully by the patient.

DR. PAUL W. SANGER, Charlotte, N. C.—It is quite apparent that those patients who are cured are seen by the surgeon fortuitously early. I have never been so fortunate. I think the objective in this paper can be accomplished more simply. I see no reason to expose these patients to a thoracotomy when one can simply introduce an intranasal polyethelene tube through which the patient can be fed. It takes care of the saliva, which is very im-

*Souttar, H. S.: Method of Intubating the Oesophagus for Malignant Stricture, Brit. M. J. **1**: 782, 1924.

portant, as most of the lesions in this portion of the esophagus (the upper half) are radiosensitive in contrast to lesions in the lower portion of the esophagus. After a period of three or four weeks the intranasal tube can be removed. The patient will die anyway, irrespective of surgery, in an average of nine months, from dissemination of the disease and not from obstruction of the esophagus.

DR. A. L. BROWN, San Francisco, Calif.—About 1947 we published in the JOURNAL OF THORACIC SURGERY a somewhat similar procedure involving the use of a rigid tube, for those individuals in whom we did not wish to do a gastrostomy. Since then we have used the same procedure in six additional cases. Our choice of cases are those in which it is determined at exploratory thoracotomy that a radical resection is not advisable. At that time we decide to put in a tube, if at all possible, so that the individual may receive irradiation therapy which, under other circumstances, we feel might shut down the esophageal lumen so tightly that we would have to use gastrostomy anyway. We have had some temporary satisfactory results with the use of the tube. One patient went a year and a half after irradiation. The tube passed about a month after insertion. The individual finally died of a cardiac ailment.

We are now using polyethelene tubes; most of our tubes extend well beyond the length of the lesion. They measure anywhere from 12 to 16 cm. in length.

We do not insert the tube through the mouth because we want to be sure, through thoracotomy, whether or not the lesion is operable. We do feel that the indwelling tube has offered these patients more comfort and relief than a gastrostomy would have offered.

DR. B. H. EVANS, Fresno, Calif.—Like Dr. Carter and Dr. Sanger, we have used an ordinary plastic vinyl tube of a type that is easily available. This is introduced directly into the esophagoscope at the time the chest is opened and the lesion found to be inoperable, being threaded through the constricted area, by bouginage if necessary, into the stomach. Then, instead of bringing the proximal end out through the nostril, we have made a small stab wound in the pyriform sinus and brought the tube out the lateral aspect of the neck. We do this because we feel that the tube can be better tolerated and the patients are more comfortable; they can swallow their own saliva around the tube and the salivary secretions find their way into the stomach. Supplemental feedings can be given through the tube as desired.

DR. JOHN M. SNYDER, Bethlehem, Pa.—Since I felt that there are still quite a few cases that we can be sure are inoperable beforehand, by evidence of cervical glandular metastases which can be proved and by invasion of the left stem bronchus determined by bronchoscopic examination, about three years ago I had a tube fashioned which I first used in a patient who had had difficulty after radiotherapy elsewhere. It was passed through the esophagoscope and worked well for several weeks. I thought we had an adequate retaining flange, but unfortunately in my first case the tube went on down within about three weeks. It did not cause the patient any intestinal difficulties, but I became a little more discouraged than Dr. Carter, because it took about ten months to get the first tube. Perhaps I can get some more in the future.

DR. EMIL A. NACLERIO, New York, N. Y.—I want to comment briefly on seven selected patients with cancer of the esophagus who were treated during the past two years with plastic tube prosthesis applied transthoracically. In patients who are extremely poor surgical risks, with complete dysphagia and/or an inoperable lesion, the use of a specially designed polyethelene tube may prove to be the optimum method of offering palliation. Earlier experiences with four patients, in whom varying lengths of involved esophagus were resected and a tube was sutured in place, gave poor results in that esophageal leaks occurred, causing mediastinal and subcutaneous emphysema, pneumothorax, pleural effusion, atelectasis and a low-grade empyema, which necessitated prolonged pleural drainage and gastrostomy. The leaks healed in two patients, and they were again able to swallow, despite an associated prolonged period of continued pleural disease; in another, death occurred in the fourth postoperative week from atelectasis, pneumothorax, empyema, and associated coronary disease; and the other, a patient with severe cardiac disease, died on the third postoperative day from coronary occlusion.

In view of the already mentioned complications, plus the difficulties which were encountered in removing the segments of involved esophagus, which at best did not remove all of the disease, and since experience has shown that tube prosthesis brings comfort to a patient and again affords normal eating, the problem was pursued with a change in technical management.

Instead of resecting the involved segment, an incision is made into the lumen of what appears to be the normal esophagus close to the obstructing area. The constricted area, if need be, may be enlarged by dilators or may be incised (bivalved), or a small portion of the wall may be resected. These maneuvers facilitate insertion of the tube. The tube is not rigid, but is slightly flexible, which facilitates its insertion and minimizes the chances of pressure necrosis and hemorrhage. The tube is to be fixed above and below. With this approach, which is somewhat similar to the method suggested by Dr. Mackler, the complications which followed when the removal of segments of the esophagus was performed have been practically eliminated.

The history is that of a 69-year-old Negro woman, who was unable to swallow, had a weight loss of 98 pounds, and was markedly dyspneic. X-rays showed marked massive pleural effusion and lung involvement in the left chest. At operation through a left-sided thoracic intercostal incision, the lung and mediastinal organs were found to be frozen. The esophagus, which could be barely approached, approximately 4 cm. above the diaphragm, was incised and a tube was inserted following dilatation of the constricted area with bougies. This patient lived for eleven and one-half months with maximum comfort.

The next case was that of a 51-year-old man with marked kyphosis, weight loss, and complete dysphagia with an obstructing lesion in the upper third. A portion of the constricted area was partially excised, thus permitting easy passage of the polyethelene tube through a separate esophagotomy incision. This patient lived fairly comfortable for six months and was joyous over the fact that he could again eat normally.

DR. W. E. ADAMS, Chicago, Ill.—I want to raise the question whether we should not continue to think more in terms of curative than palliative therapy. Although most of us have had a poor showing so far as long-time survival is concerned, if our attitude toward it turns toward palliative rather than curative measures, the outlook for future success in surgery will not be improved. Dr. Graham raised this point in the case of carcinoma of the lung about ten or twelve years ago. Although we still have much to attain in the way of curative results in carcinoma of the lung, progress will be made if we keep curative therapy in mind in all cases.

Dr. Mackler's slides did not include long-time survival cases of the late Dr. Phemister and myself. We have had only five cases which have gone between five and fifteen years following operation, representing approximately 3 to 4 per cent of all patients explored. I believe if we are to use these palliative procedures, unless there is definite evidence of spread of the tumor, that they should be used only after exploration and demonstration that the lesion is not resectable.

DR. S. MACKLER (Closing).—I wish to thank the discussants for their comments and participation. I shall not attempt to answer all the questions because of the limitation of time. In answer to Dr. Benedict, however, time did not permit my acknowledging the authors who previously worked along similar lines, particularly Dr. Souttar who originally, in 1927, passed metallic tubes via the esophagoscope. Dr. Brown and Dr. Ravitch also mentioned the use of a tube in a single case at later dates. They are, of course, mentioned in the published paper.

In answer to Dr. Sanger's suggestion that the tube be inserted through the mouth without thoracotomy, I should like to say that without the operation one could not determine whether or not the lesion is resectable. In answer to Dr. Adams' question, I feel that if palliative procedures were done only where palliation is indicated, and resection and esophagogastrostomy done where a cure can be expected, then we would anticipate that the ultimate figures for resection and esophagogastrostomy would be far superior to what they are today.

Announcements

THE AMERICAN ASSOCIATION FOR THORACIC SURGERY

Notice of Annual Meeting

The Thirty-fifth Annual Meeting of the American Association for Thoracic Surgery will be held April 24, 25, and 26, 1955, in Atlantic City, New Jersey. Headquarters will be at the Chalfonte-Haddon Hall.

Requests for Hotel Reservations

These should be mailed directly to Miss Doris Sears, Convention Manager, Chalfonte-Haddon Hall, Atlantic City, New Jersey. Please mention this Association, the type of accommodation desired, date and approximate hour of arrival. If accommodations are desired elsewhere in Atlantic City, please communicate directly with the hotel of your choice.

Thoracic Surgical Forum

By vote of the membership, the Forum is to be continued for the presentation of short papers on current thoracic research, experimental problems, anatomical studies and modified or new surgical techniques. The inclusion of any considerable amount of clinical material in these reports makes the choice more difficult and the Program Committee reserves the right to reject such papers or to suggest their transferral to the regular program. Papers at this session will be limited sharply to ten minutes, including the showing of lantern slides or other illustrative material. At the discretion of the President, three minutes may be allowed as the maximum discussion for each paper.

These papers will be published together in one issue in the JOURNAL OF THORACIC SURGERY. Maximum length: 3,000 words without illustrations. If illustrated, an appropriate number of words must be subtracted for each cut used.

Abstracts for Papers

Abstracts for the presentation of papers at the 1955 meeting, including papers before the Forum, must be received on or before Dec. 15, 1954; otherwise they will not be considered by the Program Committee.

Abstracts should be labeled "For Thoracic Surgical Forum," or "For Regular Program."

Five, repeat, five copies of each abstract must be sent to the Secretary of the Association, Dr. Paul C. Samson, 3959 Happy Valley Road, Lafayette, California. They should not be sent to the Editor.

The abstracts should contain from 200 to 250 words and accurately reflect the contents of the completed paper.

Applications for Membership

Applications for Associate Membership in the Association must be received by the Membership Committee not later than Dec. 15, 1954; otherwise, the applications will be deferred for consideration until 1956.

Applicants must be sponsored by three Active or Senior members of the Association. In addition to the signatures on the application form, the sponsors must forward a *separate* letter concerning the applicant directly to Dr. Lyman A. Brewer, III, Chairman of the Membership Committee, 2010 Wilshire Blvd., Los Angeles 5, Calif.

Completed application forms and the sponsoring letters *independently* sent by the three sponsors must be received by Dr. Brewer not later than Dec. 15, 1954, to be considered for action in Atlantic City.

Sponsors are reminded that *new* letters of recommendation must be forwarded to the Membership Committee should their applicants be held over for reconsideration a second year.